NT-02-25

# One weeks Coal Production at an Underground Coalmine

# One weeks Coal Production at an Underground Coalmine

## Numerical Picture of the Mine

| Tunnel | | | |
|---|---|---|---|
| 1. (0, 0, 0) | 25. (200, 80, 0) | 49. (360, 80, 0) | 73. (560, 80, 0) |
| 2. (780, 0, 0) | 26. (240, 80, 0) | 50. (400, 80, 0) | 74. (600, 80, 0) |
| 3. (780, 0, 6) | 27. (240, 120, 0) | 51. (420, 120, 0) | 75. (600, 120, 6) |
| 4. (780, 80, 6) | 28. (240, 120, 6) | 52. (420, 120, 7) | 76. (600, 120, 6) |
| 5. (780, 80, 0) | 29. (240, 80, 6) | 53. (420, 80, 7) | 77. (600, 80, 6) |
| 6. (0, 80, 0) | 30. (200, 80, 6) | 54. (360, 80, 7) | 78. (560, 80, 6) |
| 7. (0, 80, 6) | 31. (200, 120, 6) | 55. (380, 120, 7) | 79. (560, 100, 6) |
| 8. (0, 0, 6) | 32. (200, 120 0) | 56. (380, 120, 0) | 80. (560, 100, 0) |

**An Analysis of One Weeks Coal Production**
**at an Underground Coalmine**
**in Eastern Kentucky**

## I. INTRODUCTION

While discussing the different topics for this Coal study Unit, one of my Advanced Mathematics students asked the question: "what happens at an underground coal mine during a one week period?". This question would eventually become the focus of this years coal study unit at our school.

As the students in my Advanced Mathematics classes discussed each of the different topics for this year's coal study unit, we decided that our unit should be broad enough to include the participation of interested students from every academic department in our school. It should also contain several other key elements that are crucial for exploring our chosen quarry to a maximum degree. First, the unit should challenge students to solve real world problems encountered in coal mining. They should have to think critically, use problem solving skills, and be engaged at the highest levels of Blooms Taxonomy. Second, the unit should emphasize contextual learning because research shows, students that are engaged in hands-on project based learning activities are much more likely to retain what they have learned. Third, the unit should address core content standards in each academic area and should satisfy specific elements for each course within the Program of Studies.

Based on our guiding question the students in my Advanced Mathematics classes were asked to come up with a concept for this year's coal study unit. We discussed the many different aspects of coal mining and eventually settled upon three topics: 1. Surface mine design, 2. One week's coal production at an underground coalmine, and 3. Coal transportation. They were then, according to interest, asked to choose from among the three topics. This year's class decided to investigate underground coal mining and specifically analyze one week's coal production at a typical underground coalmine in Eastern Kentucky.

The students in each participating class were given the task of investigating at least one specific

element of coal production at the mine site during the seven day period. To get the unit started, students that were enrolled in our pre-engineering curriculum were placed in groups of four and asked to design a small underground coalmine and show the advancement of the mine during the seven-day period.

The unit addressed the following major objectives; and the student will

1. Use computer design software ( SurpacVision, MineSimU, AutoCad, ect. )to accurately project and map the extension of the mine during the one week period.
2. Use techniques of Integral Calculus to calculate the fluid force on the outer wall of the coalmine after it had filled with water to within 15% of the accepted value.
3. Use core drilling data and geostatistical techniques of Inverse Distance and Delauney Triangulation, to predict the height of the coal seam at a pond located on the property to within two foot of the accepted height.
4. Use the polygonal method to accurately estimate the volume of coal in the coal seam and determine its current market value.
5. Use Surfer 8 computer software to estimate the volume of coal in the coal seam to within 15% of the accepted value.
6. Use a computer ventilation software program ( VnetPC 2000, MineVent, ect. ) to accurately design a ventilation schematic of the coalmine.
7. Use Surfer 8 computer software to correctly draw at least two different 2-dimensional pictures of the coal seam.
8. Use Surfer 8 computer software to correctly draw at least two different 3-dimensional pictures of the coal seam.
9. Use core drilling data and Surfer 8 computer software to predict the height of the coal seam at a gas well located on the property to within one foot of the accepted value.
10. Use algebraic and geometrical techniques to calculate the diameter of the roof bolts needed during the one week period to within 10% of the accepted value.
11. Correctly use algebraic techniques to estimate the maximum pillar size during the one-week period if the mine incorporates square pillars and maximum recovery is desired (50%).
12. Correctly use algebraic techniques to determine the minimum laboratory compressive strength of the coal at the mine in order for stability to be achieved.
13. Correctly use algebraic techniques to determine the safety factor for compressive failure of the mine pillars by utilizing the Holland-Gaddy relationship.
14. Use algebraic and geometrical techniques to calculate the distribution of air according to natural splitting among at least four parallel splits to within at least 20% of the accepted value.
15. Use algebraic and geometrical techniques to determine the pressure drop and the air horse-power along the panel to within 20% of the accepted value.
16. Analyze the ash, moisture, BTU, and sulfur content of the coal that is mined at the site to within 15% of the accepted value.
17. Determine the impact of pressure change on the on the ventilation system of the

underground coal mine to within 20% of the accepted value.

13. Correctly use technology as a tool to assist in making decisions about the development and operation of the surface mine.
15. Correctly research the history of underground coal mining in Eastern Kentucky using at least 2 sources.
16. Given the material, bake a cake or pastry that correctly models the coal seam and the surrounding rock strata.
17. Given the necessary tools, be able to compose the music and/or lyrics of a song that is at least 3 minutes long and has coal as a central theme.
18. Given the materials, construct a 2-dimensional or 3-dimensional work of art that correctly illustrates underground coal mining and its impact on the people of our area.
19. Be able to write a proficient short story or poem that has coal as the central cluster theme.

There are 15 essential questions that were realized in this unit:

1. How can I calculate the fluid force of water on the sides of an abandoned underground coalmine that has filled up with water?
2. What is the volume and current value of the coal located at the property?
3. If there were a gas well on the property, how can I use core drilling data to predict the height of the coal at the well?
4. What is the history of underground coal mining in Eastern Kentucky?
5. How has underground coal mining impacted the lives of the people in Eastern Kentucky?
6. How can I determine the ash, moisture, sulfur, and BTU content of the coal mined at the site?
7. How can technology be used in the design and operation of an underground coal mine?
8. How do you write a song about coal mining?
9. How is coal used in as a theme in different types of art?
10. How can I write a short story or essay about coal?
11. How can I draw a ventilation schematic of a small underground coalmine?
12. How do rough sides and bends cause the air pressure to change in the mine?
13. What is a coal separation flow-chart?
14. How can I illustrate a coal seam by baking a cake or pastry?
15. How can I use computer simulation software to design an underground coalmine?

## II. ACTIVITIES AND GOALS

This year's coal study unit was an interdisciplinary integration project involving all academic departments at the school. It was integrated horizontally across all subject areas in such a way that the student participated in and became part of a total immersion learning activity. The student practiced

cooperative learning and peer teaching skills through collaboration with and by working with other students in small groups. They will use critical thinking and problem solving skills to make decisions concerning the planning and operation of an underground coalmine while applying and transferring previously learned skills to real life problems face in today's mines. The following is a brief description of the learning activities implemented in each subject at our school.

**A. MATHEMATICS**

My Advanced Mathematics students were placed in groups of four and asked to use pre-calculus techniques to investigate at three two problems that would typically be encountered at the underground mine during the two-week period. Each group could brainstorm and develop their own problem criteria or the group could analyze at least three criteria from the list below:

1. Use core-drilling data from the coal seam and polygonal method to estimate the volume and value of the coal located on the property.
2. Predict the height of the coal seam beneath a pond that is located on the property directly over the projected mine advance.
3. Determine the minimum size roof bolts that will be needed to support the roof as the mine advances during the week.
4. Calculate the minimum size of the coal pillars that will be needed to support the roof as the mine advances over the seven day period.
5. Calculate and utilize the Holland-Gaddy relationship to determine the "Safety Factor" for compressive failure of the mine pillars.
6. Calculate the distribution of air along the advancing mine panel according to natural splitting.
7. Determine the pressure drop and air horsepower along the mine panel.

Students enrolled in my AP Calculus class investigated problems that would be encountered at the mine if a low lying part of the mine were to fill with water. They used techniques of integral calculus to calculate the fluid force exerted by the water on the vertical side of the mine wall closest to the hillside. They also investigated whether this force could be reduced if the mine wall closest to the hillside were slanted at a 45-degree angle. They calculated the amount of time and the size of two pumps that would be needed to pump the water out of the mine. These students also used integral calculus to calculate the amount of

"work" needed to pump the water from the low-lying area inside the mine to a higher point outside the mine.

**B. SCIENCE**

Chemistry students used laboratory methods to determine the ash, moisture, and BTU content of the coal taken from the mine.

Physics students performed a coal separation simulation laboratory exercise and used a computer simulation software program to simulate the separation of coal and rock extracted from the mine. These students investigated the change in the frictional pressure drop along the air pathway of the mine as a function of the airflow ($ft^3$/min). They focused on two variables associated with underground coalmine ventilation.

1. How does the "roughness or coarseness" of the sides of the mine impact the frictional pressure drop along the air pathway?
2. How do the corners in the air pathway (bend and yaw) impact the frictional drop along the air pathway?

These ventilation experiments were performed in the school commons area on three 40-foot long wind tunnels.

**C. Pre-Engineering**

Students enrolled in our Pre-engineering curriculum worked in groups of four to calculate the volume of the coal seam located on the property. They used Surfer 8 Contouring and 3-D Mapping Computer Software to determine the volume of the coal seam and the height of the coal directly beneath a pond that is located over the area to be mined. Each group then generated a numerical picture of the mine. They then entered this data into our SURPAC VISION computer design software

and generated 2-dimensional and 3-dimensional pictures of the coalmine. They also had to show the area to be mined during the one-week period on the mine maps. After designing the mine, the pre-engineering students used Vnet 2000 ventilation simulation software to ventilate their mine. This program generated a schematic using the 3-dimensional coordinates of the junction and branches of the mine.

**D. ENGLISH**

Senior English student wrote short stories and poems with coal as a central cluster theme. Several students decided to use their papers as entries in the senior English portfolios.

**E. SOCIAL STUDIES**

Political Science students used the library facilities to research topics related to the history of underground coal mining in Eastern Kentucky.

**F. TECHNOLOGY**

Technology was used in every academic area as a powerful tool to solve complex problems and make important decisions concerning the development of their mine. The application of technology in this unit was both challenging and relevant to the problems faced in underground coal mining. A list of some important types of technology used in our unit would include: Computers, Surfer 8 Simulation Software, Vnet 2000 Ventilation Simulation Software, calculators, VCR, TV camcorders, sound mixers, digital camera, mapmaking hardware, and the Internet.

**G. ART**

Students in the art department were asked to produce 2-dimemsional and 3-dimenstional works of art with coal as the central theme. These could include sculpturing, posters, paintings, coal drawing, and photographs.

**H. MUSIC**

Music students composed and recorded songs about various aspects of coal mining and its impact on the people of Eastern Kentucky.

**I. FOOD SERVICES**

Students in the culinary skills course baked cakes and pastries that illustrated a 3-dimensional "cut-a way" view of the coal seam and the surrounding rock strata. They then shared these baked goods with other students and faculty members within the school community.

**III. SUMMARY**

Students at our school had fun participating in this unit and they learned a lot about underground coal mining.

This year's coal study unit must be considered a success. It successfully exposed our students to most aspects of coal production in an underground coalmine over a seven-day period. The students learned in a contextual manner and used hands-on, technology intensive activities that helped them retain what they learned. They became active learners in a coal related integration project involving all academic areas.

Our pre-engineering students will experience an additional positive impact from our unit. Due to the training they received with the mine design computer software, they will have an opportunity to market job ready skills to any number of engineering firms located in our area. This could provide them the training they need to work after school or during the summer at a challenging job earning double or triple the salary earned by their minimum wage earning peers.

Students participating in our unit were engaged at the highest levels of Blooms Taxonomy: analysis, synthesis, and evaluation. They were asked to judge the success of the entire unit and make recommendation for improvements. Several of these recommendations may be use to improve the unit when it is taught again. Students were also asked to judge and critique each other's culmination projects. They listed two things they liked about the project and noted one area in which the project

could be improved. These evaluations became a valuable tool that many students used to improve their projects.

Participating teachers in each department evaluated their students using one or all of the following methods:

1. Formative Evaluation
    a. Daily oral questions of students by the teacher
    b. Oral presentation
    c. Open-response questions
    d. Investigation and group product evaluations
    e. Quizzes
2. Summative Evaluation
    a. Culminating projects
    b. Unit tests

The participating teachers and the unit coordinator evaluated the effectiveness of the unit based upon the degree to which the unit taught the high school core content, covered the program of studies, and met components of our schools consolidated plan. It was apparent that this unit met and exceeded all expectations set by participating teachers at the inception of the unit.

One aspect of this unit that will need improvement is the greater distribution if the computer simulation software at our school. Due to the expense of these software packages, we were only able to purchase one site license for both the contouring and ventilation software simulation packages. This severely restricted the number of students that were able to use their software packages. Extra site licenses should be purchased when this unit is taught again.

The activities taught in this unit were designed to allow student the opportunity to learn in the type of multiple intelligence and style of learning that best suited their needs. All the participating teachers were able to differentiate their instruction to meet the needs of student containing IEP modification. These would include special education students, 504 students, and students in our gifted and talented program. To see a complete list of these components, see the coal study unit outline included in this report.

This year's coal study unit involved the active participation of 20 teachers, 404 students, and one administrator. It has excited the entire community at our high school. Almost every student at our school is aware of at least one of the activities in our coal study unit. The responses of the student that participated in the unit were overwhelmingly favorable. They believe that their knowledge of underground coal mining has been enhanced. They indicated that they especially like the hand-on nature of the instructional activities and they enjoyed working with other students in the cooperative learning peer teaching aspects of the unit.

In conclusion, this coal study unit must be considered a total success because the goal set for the unit was achieved. The 23 objectives were either met or exceeded and the four elements described in the introduction were all realized. Student learning was enhanced. Their critical thinking and problem solving skills have been improved. Most importantly, these students will take with them a greater understanding of underground coal mining, an appreciation of the difficult job performed by coal miners, and a great realization of how important coalmining is to Pike County, the state of Kentucky, and the United States of America.

# LESSON PLAN

**Date: January 2 – May 15, 2009** **Teacher:**
**Type:** ☐ Daily ☒ Unit **Length:** __75__ (# days) **Class :**

**THEME/ORGANIZER:**

**One weeks coal production at a typical underground coalmine in Eastern Kentucky.**

**TARGET STANDARD(S):** (Expressed in High Order Thinking Skills, "HOTS"/Williams and Blooms Taxonomies)
**The students will be able to:**

1. **Use computer design software ( SurpacVision, MineSimU, AutoCad, ect. )to accurately project and map the extension of the mine during the one week period.**
2. **Use techniques of Integral Calculus to calculate the fluid force on the outer wall of the coalmine after it has been abandoned and filled with water to within 15% of the accepted value.**
3. **Use core drilling data and geostatistical techniques of Inverse Distance and Delauney Triangulation, to predict the height of the coal seam at a pond located on the property to within two foot of the accepted height.**
4. **Use the polygonal method to accurately estimate the volume of coal in the coal seam and determine its current market value.**
5. **Use Surfer 8 computer software to estimate the volume of coal in the coal seam to within 15% of the accepted value.**
6. **Use a computer ventilation software program ( VnetPC 2000, MineVent, ect. ) to accurately design a ventilation schematic of the coalmine.**
7. **Use Surfer 8 computer software to correctly draw at least two different 2-dimensional pictures of the coal seam.**
8. **Use Surfer 8 computer software to correctly draw at least two different 3-dimensional pictures of the coal seam.**
9. **Use core drilling data and Surfer 8 computer software to predict the height of the coal seam at a gas well located on the property to within one foot of the accepted value.**
10. **Use algebraic and geometrical techniques to calculate the diameter of the roof bolts needed during the one week period to within 10% of the accepted value.**
11. **Correctly use algebraic techniques to estimate the maximum pillar size during the one-week period if the mine incorporates square pillars and maximum recovery is desired (50%).**
12. **Correctly use algebraic techniques to determine the minimum laboratory compressive strength of the coal at the mine in order for stability to be achieved.**
13. **Correctly use algebraic techniques to determine the safety factor for compressive failure of the mine pillars by utilizing the Holland-Gaddy relationship.**
14. **Use algebraic and geometrical techniques to calculate the distribution of air according to natural splitting among at least four parallel splits to within at least 20% of the accepted value.**
15. **Use algebraic and geometrical techniques to determine the pressure drop and the air horse-power along the panel to within 20% of the accepted value.**
16. **Analyze the ash, moisture, BTU, and sulfur content of the coal that is mined at**

**the site to within 15% of the accepted value.**

17. **Determine the impact of pressure change on the on the ventilation system of the underground coal mine to within 20% of the accepted value.**
13. **Correctly use technology as a tool to assist in making decisions about the development and operation of the surface mine.**
15. **Correctly research the history of underground coal mining in Eastern Kentucky using at least 2 sources.**
16. **Given the material, bake a cake or pastry that correctly models the coal seam and the surrounding rock strata.**
17. **Given the necessary tools, be able to compose the music and/or lyrics of a song that is at least 3 minutes long and has coal as a central theme.**
18. **Given the materials, construct a 2-dimensional or 3-dimensional work of art that correctly illustrates underground coal mining and its impact on the people of our area.**
19. **Be able to write a proficient short story or poem that has coal as the central cluster theme.**

**ESSENTIAL QUESTION(S):**

1. **How can I calculate the fluid force of water on the sides of an abandoned underground coalmine that has filled up with water?**
2. **What is the volume and current value of the coal located at the property?**
3. **If there were a gas well on the property, how can I use core drilling data to predict the height of the coal at the well?**
4. **What is the history of underground coal mining in Eastern Kentucky?**
5. **How has underground coal mining impacted the lives of the people in Eastern Kentucky?**
6. **How can I determine the ash, moisture, sulfur, and BTU content of the coal mined at the site?**
7. **How can technology be used in the design and operation of an underground coal mine?**
8. **How do you write a song about coal mining?**
9. **How is coal used in as a theme in different types of art?**
10. **How can I write a short story or essay about coal?**
11. **How can I draw a ventilation schematic of a small underground coalmine?**
12. **How do rough sides and bends cause the air pressure to change in the mine?**
13. **What is a coal separation flow-chart?**
14. **How can I illustrate a coal seam by baking a cake or pastry?**
15. **How can I use computer simulation software to design an underground coalmine?**
16. **What substances are used to filter out $CO_2$ gas in a self-respirator?**

**DIFFERENTIATED INSTRUCTION:** ***(Place initials of students beside modifications needed)***

IEP Modifications:

# LESSON PLAN

[x] Extended Time
[x] Individualized Assistance
[x] Reading Assistance
[x] Reduced Work
[ ] Preferential Seating
[x] Modified Grading
[x] Oral Assessment
[x] Use of Calculators
[ ] Highlight Information to be Learned
[x] Slow the Rate of Presentation
[ ] Other *(Explain)*

GT Modifications:

[x] Additional Instruction and Assistance
[x] Enrichment Activities
[x] Research
[ ] Other

Multiple Intelligencies:

[x] Linguistics
[x] Spatial
[x] Logical/Mathematical
[x] Musical
[x] Bodily/Kinesthetic
[x] Interpersonal
[x] Intra-personal
[x] Naturalist/Outdoors
[ ] Other

Learning Styles:

[x] Verbal
[x] Active
[x] Auditory/Verbal
[x] Kinesthetic
[x] Sensing
[x] Sequential
[x] Reflective
[x] Introversion
[x] Extraversion
[x] Reflective
[x] Visual
[x] Intuitive
[x] Global

Cooperative Learning:

[x] Jigsaw
[ ] Think-pair-share
[ ] Other

Other:

## PROCEDURES:

## MATHEMATICS

1. **Students will be placed in cooperative learning/peer teaching groups and assigned the task of designing a core drilling pattern and generating a numerical picture of the mine site.**
2. **Students will work in groups of four to determine the extraction ratio, size of the remaining coal pillar, and the minimum roof bolt size needed for the mine.**
3. **Each group will use the methods of inverse distance and/or delaunay triangulation to predict coal seam height at a specific point by using the surrounding core drilling data.**
4. **Each group will work in groups of four to use the polygonal method to estimate the volume of coal at the mine site and determine its current market value.**
5. **Each group will verify the height of the coal seam at the specific point by using Surfer 8 computer software.**
6. **Students in the AP Calculus class will work in groups of four to anticipate and prevent a mine blowout by calculating the fluid force on the sides of the mine after it has been abandoned and filled with water.**

# LESSON PLAN

## SCIENCE

1. **Review laboratory methods and safety procedures with class as a large group.**
2. **Students will be placed in a group with 3 other lab partners and assigned the task of determining the ash, moisture, BTU, and sulfur content of a sample of coal.**
3. **Chemistry students will work in groups of 4 to investigate the capacity of at least 2 substances to absorb carbon monoxide that may be present in the mine after a fire or explosion.**
4. **Physics students will work in groups of 4 to set up a wind tunnel simulation of the airflow inside the mine using 3-inch diameter PVC pipe. They will investigate the effect that "rough sides" and "bend and yaw" has on the air pressure inside the mine.**

## PRE-ENGINEERING

1. **These students will work in groups of four to use a computer software program ( SurpacVision, MineSimU, AutoCad, ect. )to design the underground coalmine.**
2. **Each group of 4 will use the Surfer 8 contouring software to determine the volume of coal in the coal seam.**
3. **Each group of 4 will produce at least four 2 and 3-dimensional pictures of the coal seam using the Surfer 8 software.**
4. **Each group of 4 will use a computer ventilation software program ( VnetPC 2000, MineVent, ect. ) to design a ventilation schematic of their underground coalmine.**
5. **Each group of 4 will use the MODSIM computer modeling software to design a workable coal separation flow-chart using input data from the coal that is mined at the mine site.**
6. **Each group of 4 will use technology as a powerful tool to assist in making decisions about the development and operation of the underground mine.**

## ENGLISH

1. **Classes were assigned the task of writing a short story, poem, or essay involving coal as a central cluster theme.**

## SOCIAL STUDIES

1. **Students were taken to the library to research the history of underground mining in our area.**
2. **Each student will work individually to write a report on his/her research findings.**

## ART

1. **Students were assigned the task of producing a 2 or 3-dimensional work of art with coal as the central theme.**

LESSON PLAN

MUSIC

1. **Students in the band and chorus classes will compose a song or write a musical play with coal as a central theme.**

HOME ECONOMICS

1. **Students will work with a partner to bake a cake or pastry that illustrates the coal seam and the surrounding rock strata.**

Review of Previous Lesson:

ENABLING KNOWLEDGE

MATH

1. **Understand variance and central tendency.**
2. **Apply right triangle trigonometry.**
3. **Solving matrix equations and evaluating 3x3 determinants by expansion of minors.**
4. **Graphing in 3-dimensions.**
5. **Calculate area and volume of polyhedrons.**
7. **Use a graphics calculator.**
8. **Understand various techniques of integration.**

SCIENCE

1. **Understand the scientific method.**
2. **Follow basic experimental procedure.**
3. **Understand and follow lab safety rules.**
4. **Understand and apply basic concepts from algebra and geometry.**
5. **Balance chemical equations.**

PRE-ENGINEERING

1. **Apply right triangle trigonometry.**
2. **Graph in 3-dimensions.**
3. **Use a graphics calculator.**
4 **Calculate area and volume of polygons.**

ENGLISH

1. **Write a short story or essay.**
2. **Construct a paragraph.**

SOCIAL STUDIES

1. **Use the internet to research a topic.**
2. **Construct a report and document sources.**

# LESSON PLAN

**ART**

1. **Understand the basics of drawing.**
2. **Be able to use a camera and develop film.**
3. **Paint with acrylic or oil.**

**MUSIC**

1. **Read and sing written music.**
2. **Use recording instruments.**
5 **Compose a musical composition.**

**HOME ECONOMICS**

1. **Understand simple baking techniques.**

**Manipulatives/Materials/Resources:**

**Calculators, rulers, protractors, compass, overhead projector, tape, graph paper, lined paper, scissors, TV., VCR, flat square, string, straightedge, graphics calculators, digital camera, Bunsen burner, beakers, graduated cylinders, computers, simulation software, drawing paper, paint, brushes, pencils, wall paper paste, mapping hardware, camcorders, sound mixers, engineering texts, and lab manuals.**

**Enrichment Activities/Learning Extensions:**

**Compare dust control at a surface mine to ventilation requirements at an underground coalmine.**

**Culminating Activities:**

**Coal Fair Projects**

**Review of Objectives in this Lesson:**

**Definitions and concepts introduced in this unit.**

**Assessment(s):** *(Attach to Lesson Plan)* **(F=Formal I=Informal)**

| | | | |
|---|---|---|---|
| [f] Multiple Choice | [f] Open Response | [i] On Demand | [f] Rubric |
| [f] Writing Portfolio | [f] Activity | [f] Quiz | [f] Test |
| [f] Graphic Organizer | [ ] Other (Explain): | | |

**Scoring Guide:** [x] Yes [ ] No *(Attach to Lesson Plan)*

**Technology Utilized:**

# LESSON PLAN

[x] Overhead Projector [x] Digital Camera [x] Scanner [x] Computer [ ] Databases

[x] Scan Converter [x] Word Processor [x] Power Point [x] Spreadsheet [x] Internet

[ ] Distance Learning [x] Graphs/Charts/etc. [x] Calculators [x] Graphing Calculators

[x] Other

**Pike County Central Comprehensive School Improvement Plan:**

**1a, 1b, 1c, 1d, 3a, 3c, 3d, 3e, 4a, 4d, 4c, 4d, 4e, 4f, 4g,**

**Literacy Action Plan:**

1. **Expand vocabulary specific it advanced mathematics.**
2. **Utilize power verbs in instruction and assessment.**
3. **Implement reading, writing, and organizing techniques in instruction.**
4. **Implement reading strategies to improve comprehension and reading speed.**
5. **Read to students and assign reading materials.**
6. **Parents will be contacted whenever a student is in danger of failing a course.**
7. **Graphic organizers will used in instruction.**

**<u>Content Specific Vocabulary</u>:**

## LESSON PLAN

**Additional Information:**

### A. ACADEMIC EXPECTATIONS

| | |
|---|---|
| **Mathematics:** | **1.5, 1.6, 1.7, 1.8, 1.9, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 5.1, 5.2, 5.3, 1.11, 1.12, 5.5, 6.1, 6.2, 6.3** |
| **Science:** | **2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 5.1, 5.2, 5.13, 5.3, 5.5, 6.1, 6.2, 6.3** |
| **Social Studies:** | **2.15, 2.16, 2.18, 2.19, 2.20, 5.1, 5.2, 5.5, 6.1, 6.2, 6.3** |
| **Music:** | **1.14, 2.22, 2.23, 2.25, 5.1, 6.1, 6.2** |
| **Art:** | **1.13, 2.22, 2.23, 2.25, 5.1, 6.1, 6.2** |
| **English:** | **1.1, 1.11, 1.12** |

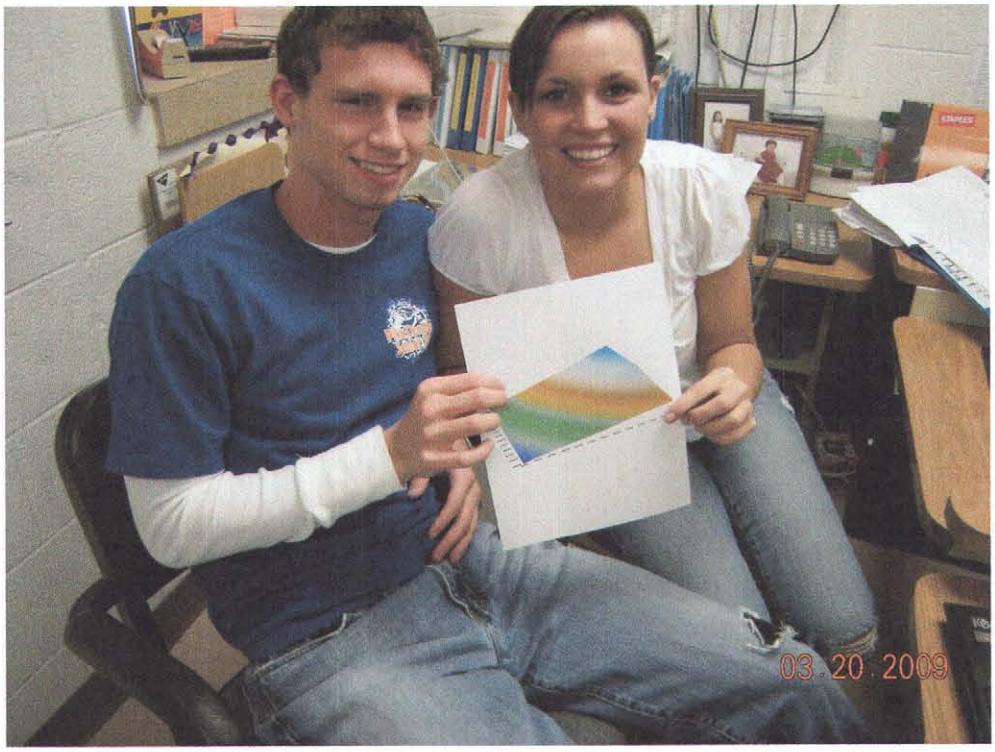
### B. CORE CONTENT

| | |
|---|---|
| **Mathematics:** | **1.1.1, 1.1.3, 1.2.1, 1.2.2, 1.2.3, 1.3.2, 1.3.4, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.2, 2.2.3, 2.2.4, 2.2.6, 2.2.7, 2.3.1, 2.3.2, 2.3.4, 3.1.2, 3.1.3, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.3.2, 3.3.4, 4.1.4, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 4.2.1, 4.2.2, 4.2.3, 4.2.4, 4.2.8, 4.3.1, 4.3.2, 4.3.5** |
| **Science:** | **1.2.5, 1.3.1, 1.3.2, 1.4.1, 1.5.2, 1.5.3, 2.1.1, 2.2.2, 2.3.3, 3.4.1, 3.4.2** |
| **Sc. Studies:** | **1.1.3, 2.3.1, 3.1.1, 3.2.3, 3.4.3, 3.4.4, 4.1.3, 4.4.2, 5.1.1, 5.1.3, 5.3.6** |
| **Music:** | **AH-H 1.1.12, AH-H 1.1.13, AH-H 1.1.34** |
| **Art:** | **AH-H 4.1.41, AH-H 4.1.3.2, AH-H 4.2.32, AH-H 4.1.33** |
| **English:** | **WR-H 1.3, WR-H 1.4** |

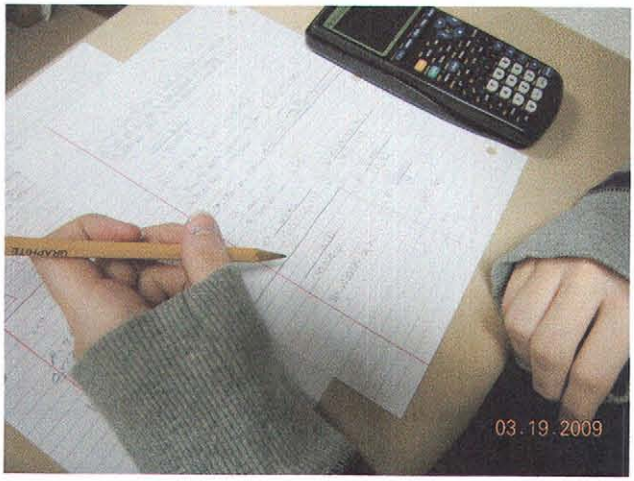
**Adjustments to the Lesson Plan:**

**Reflections:**

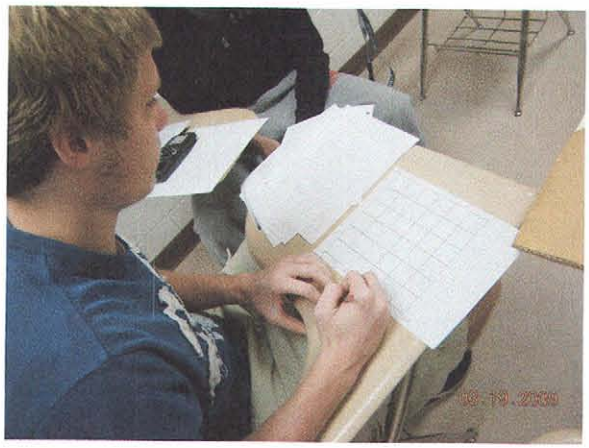
# A Picture Is Worth a Thousand Words



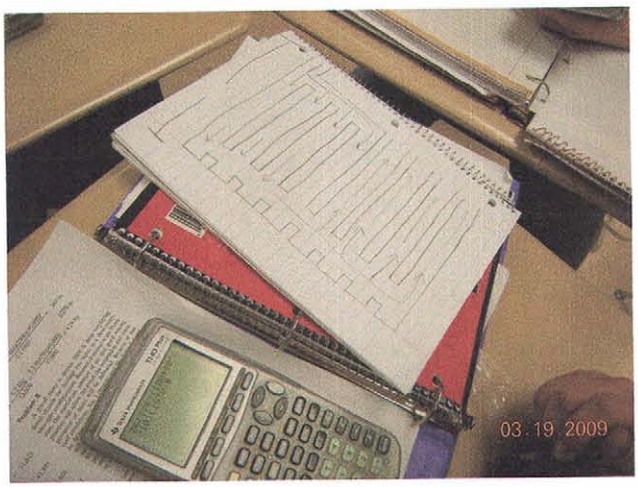
# Mathematics




Calculating Roof Bolt Size

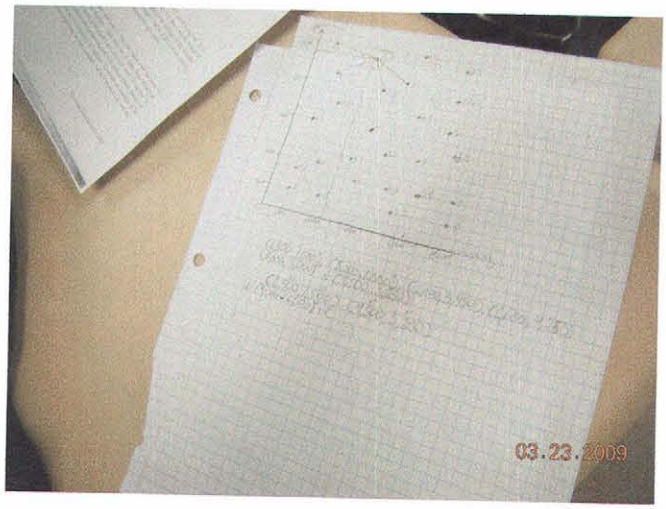


2-D layout of the coal seam

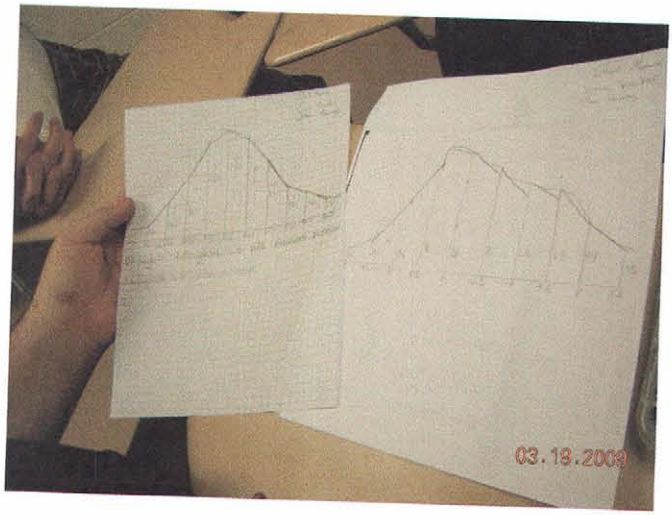



Air Distribution

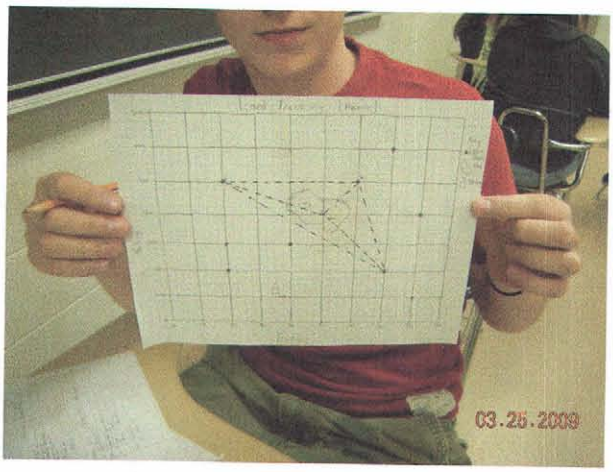
# Mathematics




Inverse distance to a square




Using trapezoids to calculate volume




Using triangulation to predict the coal seam height

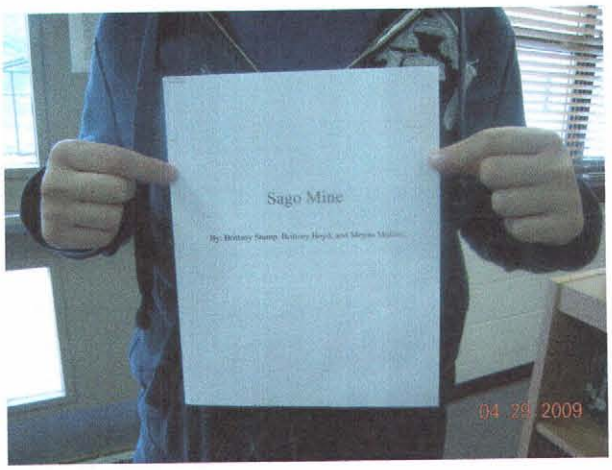
# Science


Ventilation Experiment - Control

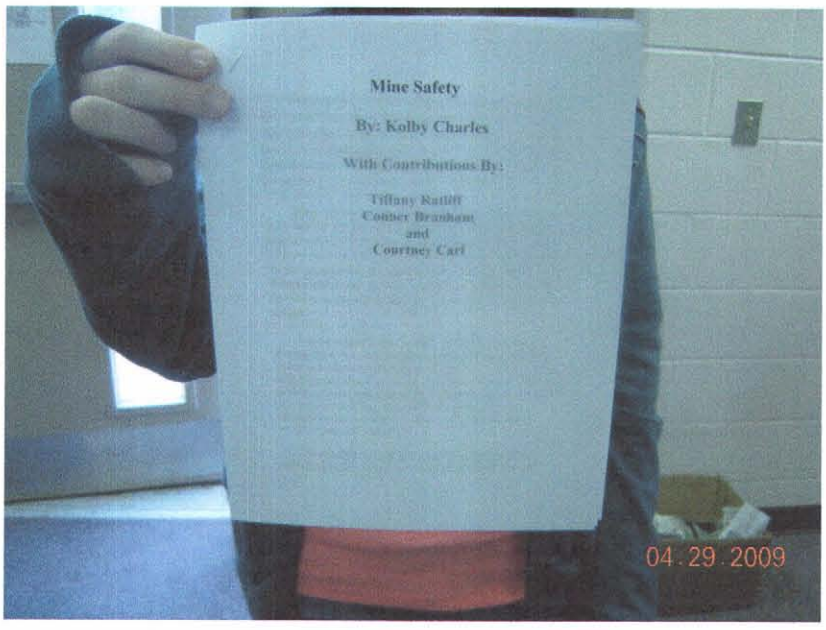

A coal/rock separation simulation


Coal analysis experiment

# Social Studies

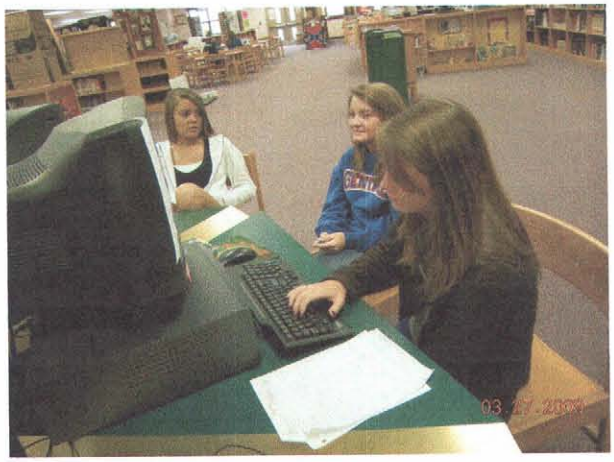



Social studies research

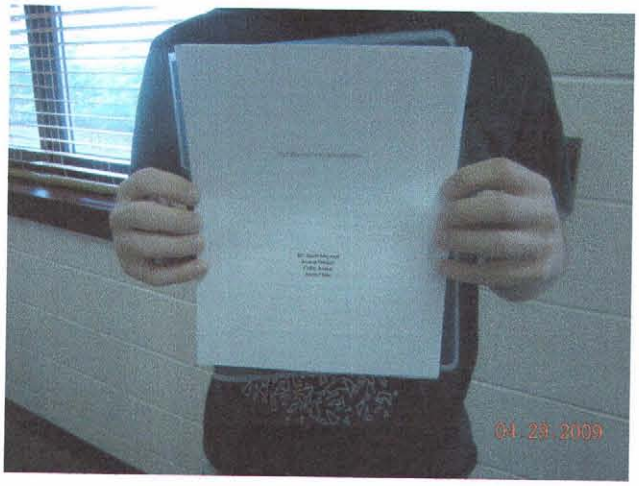



Social studies research on mine safety

# English



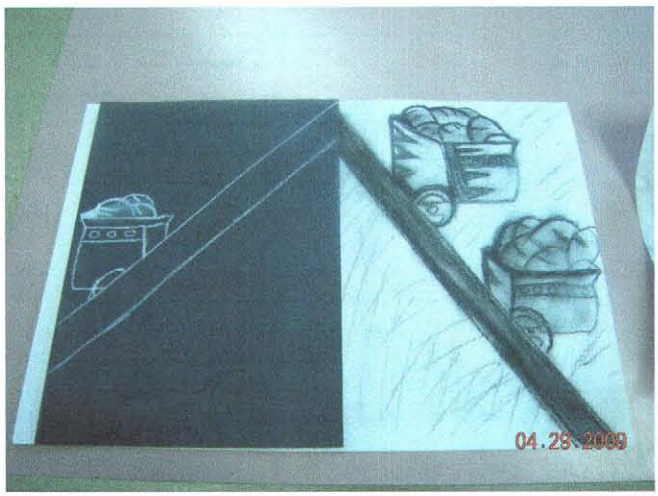
Writing an English paper



A finished English paper

# Art

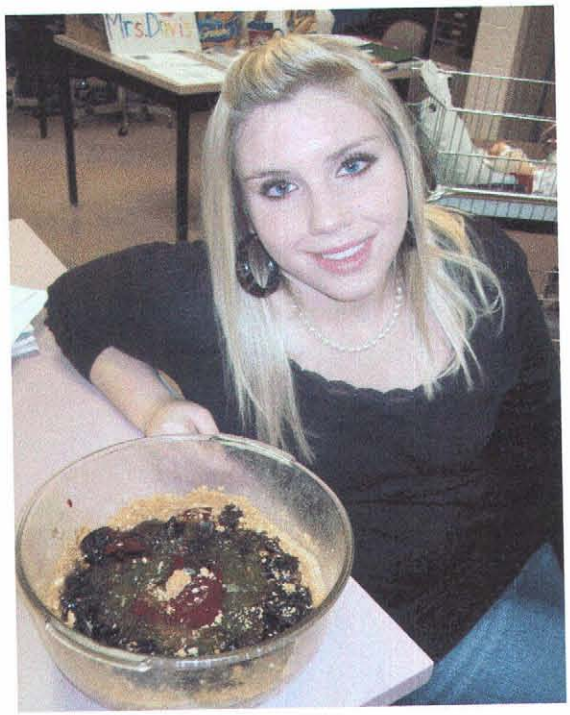

A unusual coal drawing




An excellent drawing!

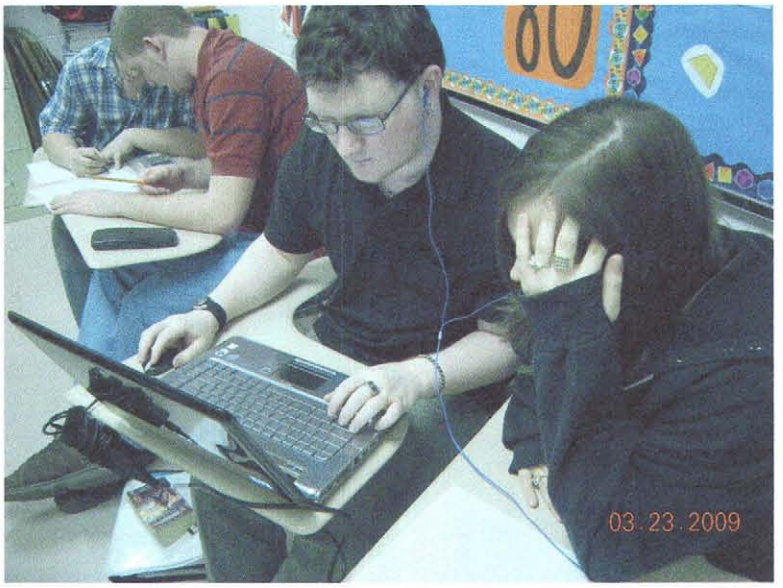
# Food Service

Beginning the mixture

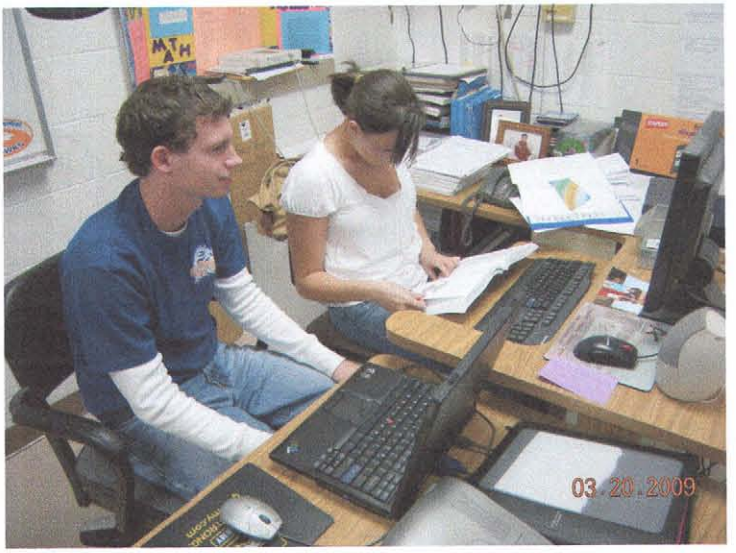


I can see the coal seam layer

# Pre-engineering




What is a numerical picture?




Entering the data

# Judging the Culminating Projects


You be the judge

# Samples

# Of

# Student

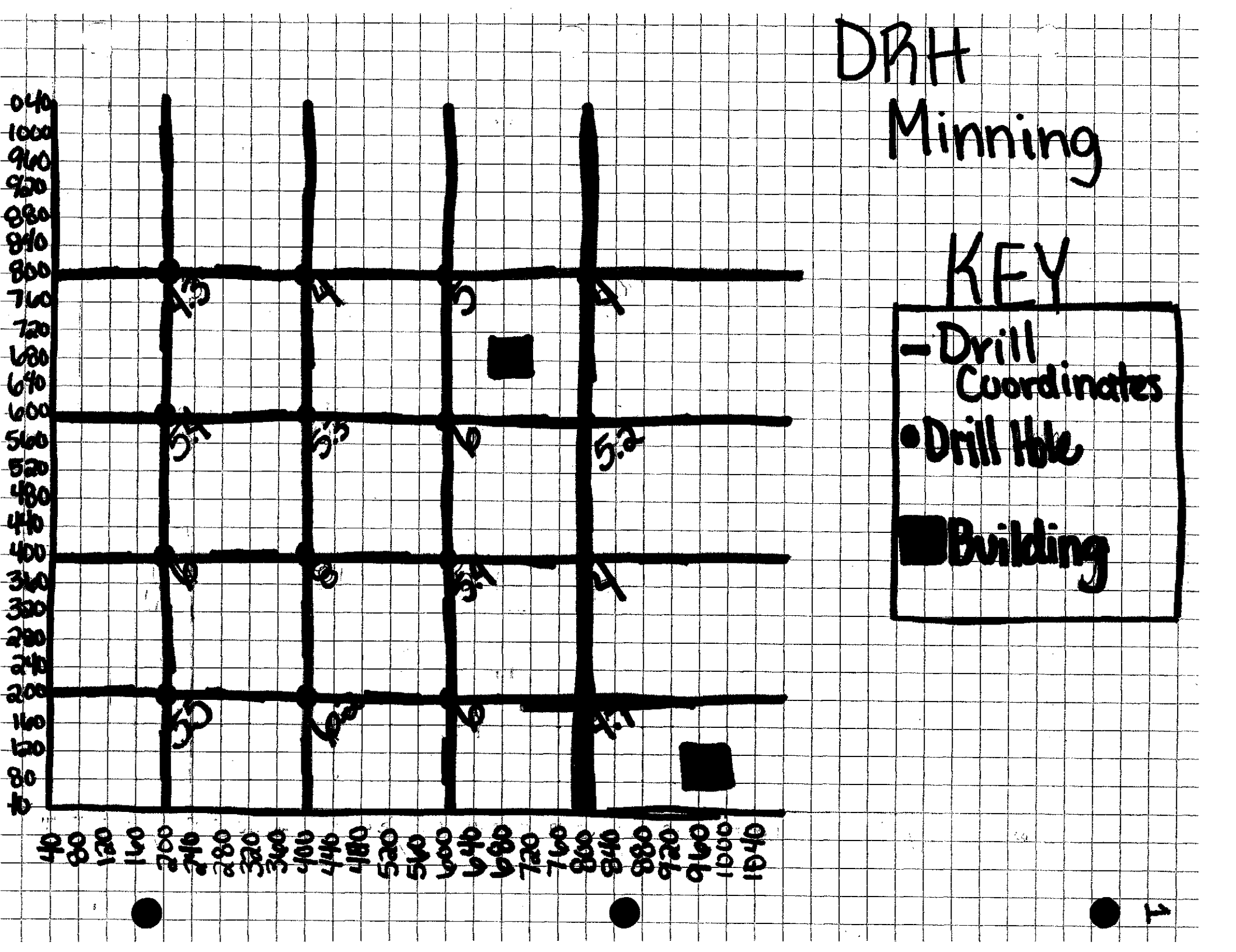
# Work

# DRH Mining

Numerical picture of the mine

2-D pictures of the mine

3-D pictures of the mine


DRH
Minning
KEY
- Drill Coordinates
• Drill Hole
Building

# Grid Volume Computations

Wed Apr 01 11:47:39 2009

## Upper Surface

| | |
|---|---|
| Grid File Name: | A:\PlotGrid.grd |
| Grid Size: | 100 rows x 100 columns |
| X Minimum: | 200 |
| X Maximum: | 800 |
| X Spacing: | 6.0606060606061 |
| Y Minimum: | 200 |
| Y Maximum: | 800 |
| Y Spacing: | 6.0606060606061 |
| Z Minimum: | 3.9999999999984 |
| Z Maximum: | 7.9999999999987 |

## Lower Surface

Level Surface defined by Z = 0

## Volumes

Z Scale Factor: 1

**Total Volumes by:**

| | |
|---|---|
| Trapezoidal Rule: | 2023988.7671022 |
| Simpson's Rule: | 2024014.9836491 |
| Simpson's 3/8 Rule: | 2024012.5907241 |

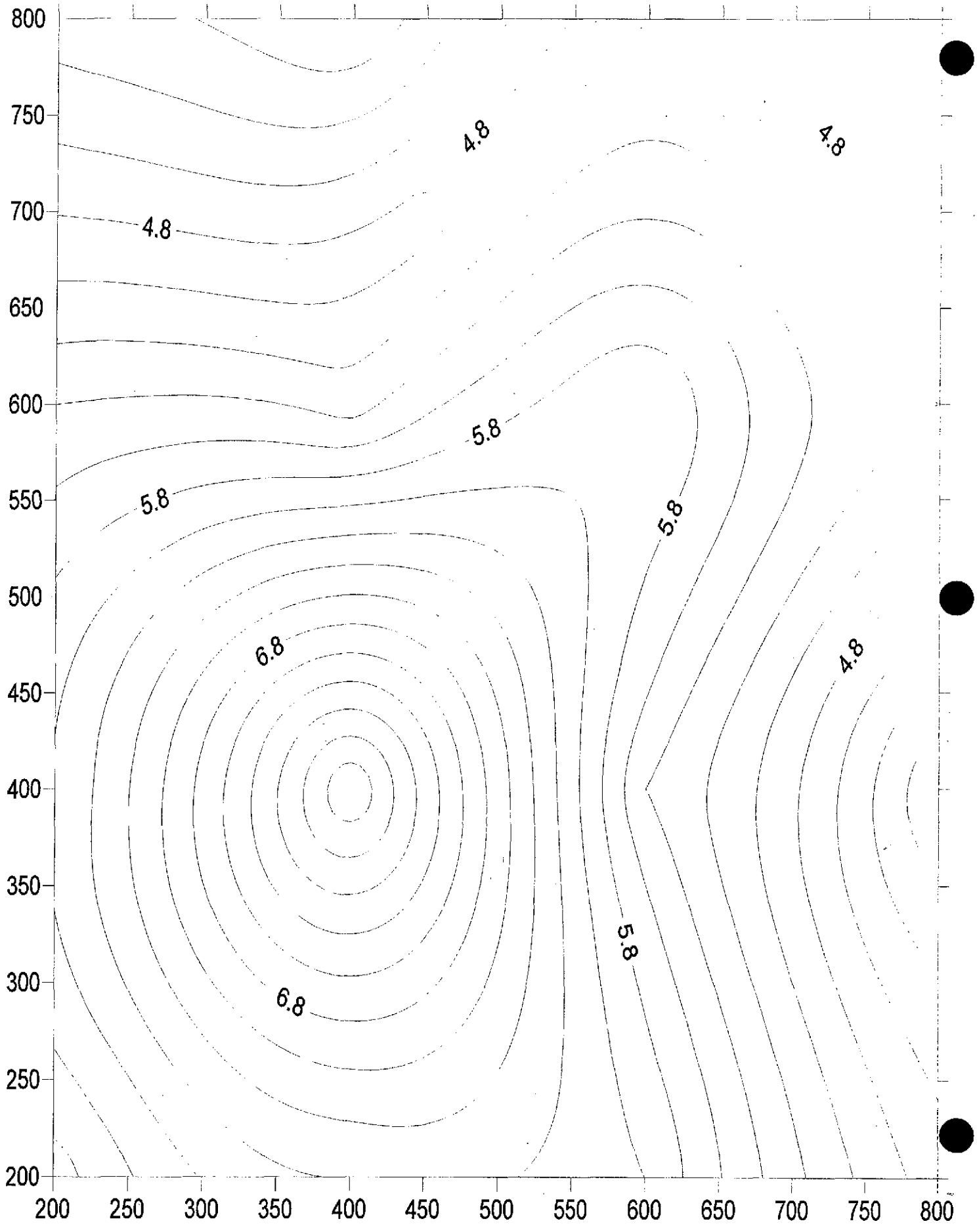
**Cut & Fill Volumes**

| | |
|---|---|
| Positive Volume [Cut]: | 2023987.2366461 |
| Negative Volume [Fill]: | 0 |
| Net Volume [Cut-Fill]: | 2023987.2366461 |

## Areas

**Planar Areas**

| | |
|---|---|
| Positive Planar Area [Cut]: | 360000 |
| Negative Planar Area [Fill]: | 0 |
| Blanked Planar Area: | 0 |
| Total Planar Area: | 360000 |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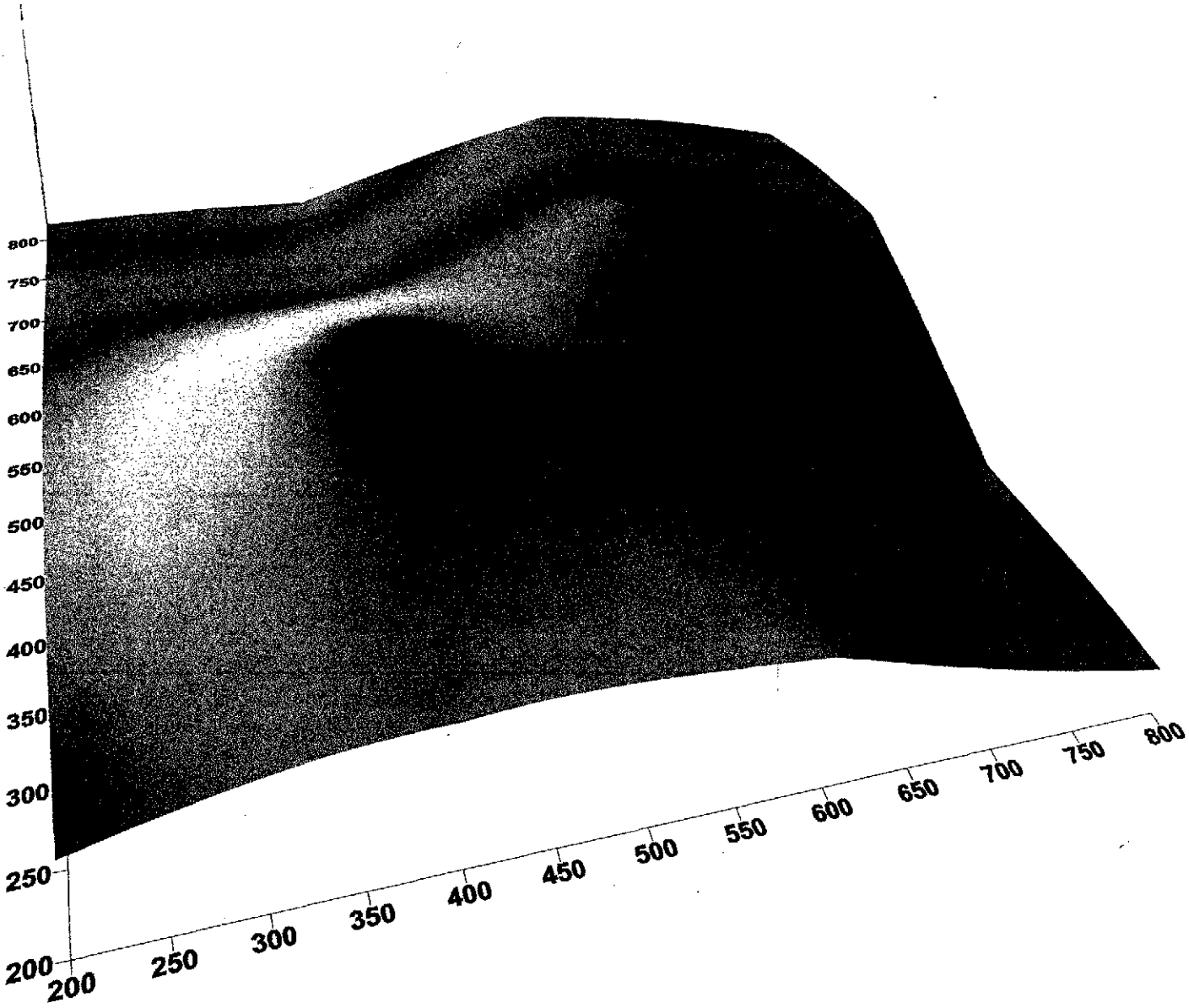
4.8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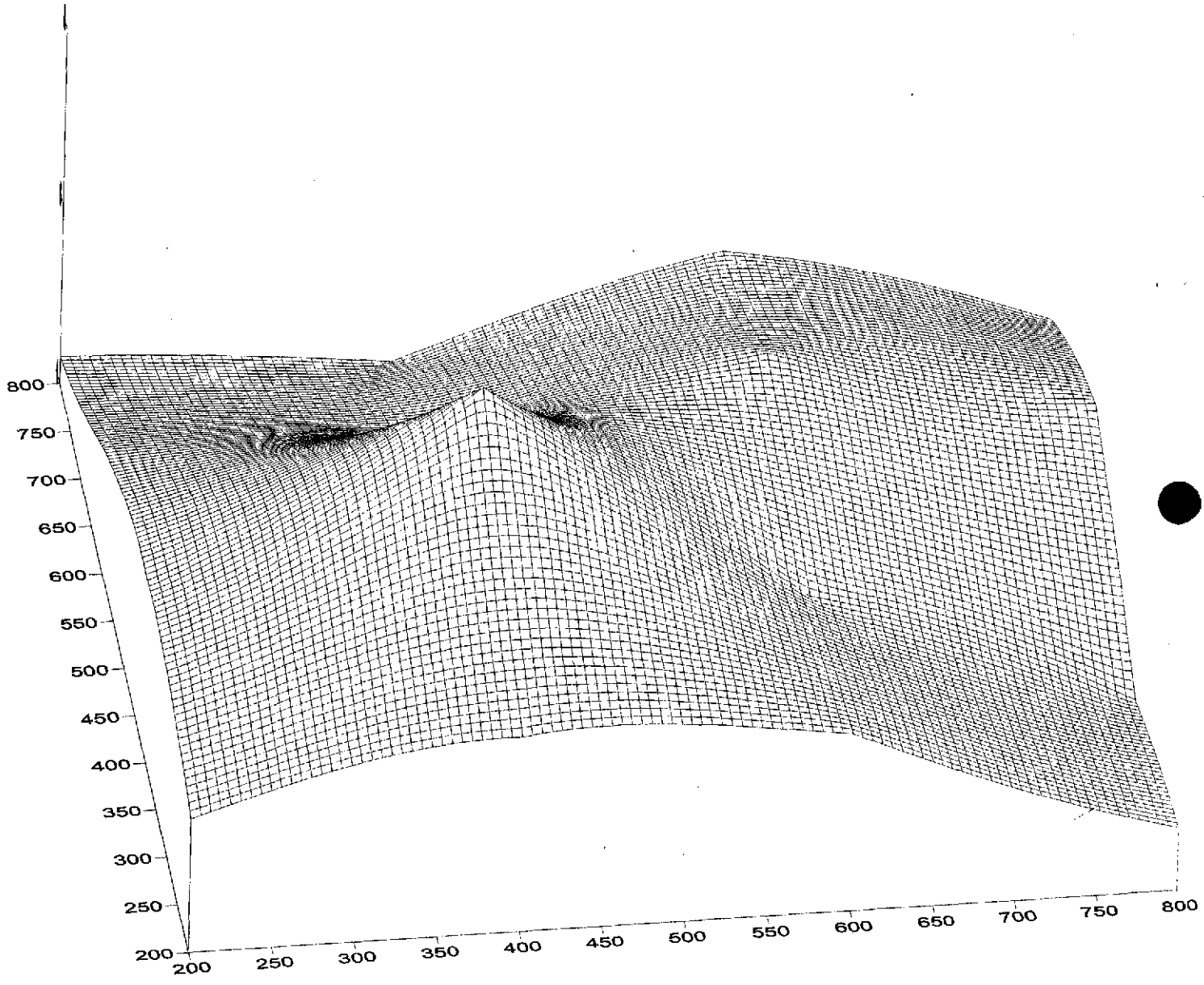
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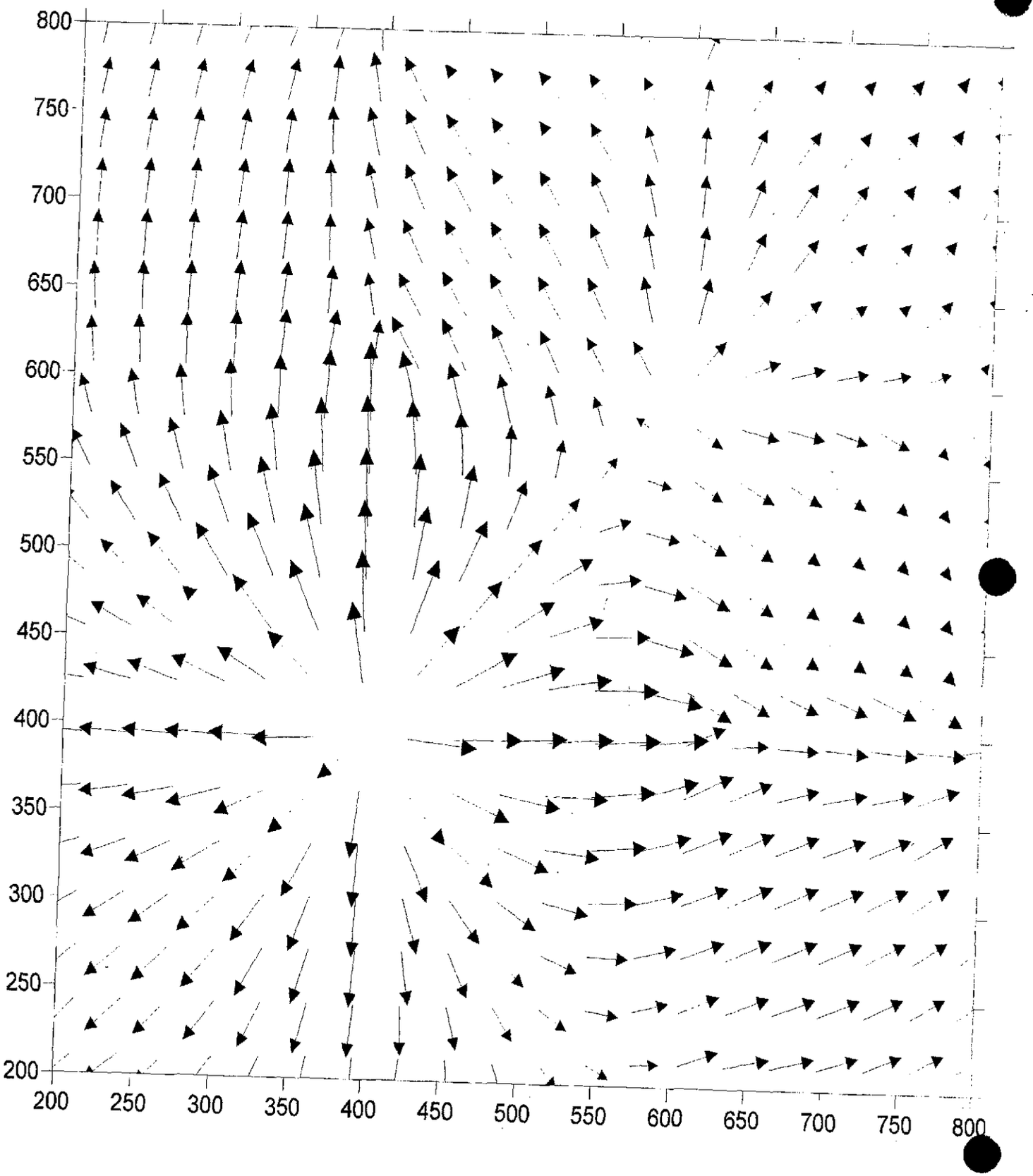
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500
550
600
650
700
750
800

# Numerical Picture of the Mine

| Tunnel | #3 | #6 | #9 |
|---|---|---|---|
| 1. (0, 0, 0) | 25. (200, 80, 0) | 49. (380, 80, 0) | 73. (560, 80, 0) |
| 2. (80, 0, 0) | 26. (240, 80, 0) | 50. (480, 80, 0) | 74. (600, 80, 0) |
| 3. (80, 0, 6) | 27. (240, 120, 0) | 51. (420, 120, 0) | 75. (600, 120, 6) |
| 4. (80, 80, 6) | 28. (240, 120, 6) | 52. (420, 120, 7) | 76. (600, 120, 6) |
| 5. (80, 80, 0) | 29. (240, 80, 6) | 53. (420, 80, 7) | 77. (600, 80, 6) |
| 6. (0, 80, 0) | 30. (200, 80, 6) | 54. (360, 80, 7) | 78. (560, 80, 6) |
| 7. (0, 80, 6) | 31. (200, 120, 6) | 55. (380, 120, 7) | 79. (560, 120, 6) |
| 8. (0, 0, 6) | 32. (200, 120, 0) | 56. (380, 120, 0) | 80. (560, 120, 0) |
| **Row 1** #1 | #4 | #7 | #10 |
| 9. (80, 80, 0) | 33. (260, 80, 0) | 57. (440, 80, 0) | 81. (620, 80, 0) |
| 10. (120, 80, 0) | 34. (300, 80, 0) | 58. (480, 80, 0) | 82. (660, 80, 0) |
| 11. (120, 120, 0) | 35. (300, 120, 0) | 59. (480, 120, 0) | 83. (660, 120, 0) |
| 12. (120, 120, 5) | 36. (300, 120, 6) | 60. (480, 120, 7) | 84. (660, 120, 6) |
| 13. (120, 80, 5) | 37. (300, 80, 6) | 61. (480, 80, 7) | 85. (660, 80, 6) |
| 14. (80, 80, 5) | 38. (260, 80, 6) | 62. (440, 80, 7) | 86. (620, 80, 6) |
| 15. (80, 120, 5) | 39. (260, 120, 6) | 63. (440, 120, 7) | 87. (620, 120, 6) |
| 16. (80, 120, 0) | 40. (260, 120, 0) | 64. (440, 120, 0) | 88. (620, 120, 0) |
| #2 | #5 | #8 | #11 |
| 17. (140, 80, 0) | 41. (320, 80, 0) | 65. (500, 80, 0) | 89. (680, 80, 0) |
| 18. (180, 80, 0) | 42. (360, 80, 0) | 66. (540, 80, 0) | 90. (720, 80, 0) |
| 19. (180, 120, 0) | 43. (360, 120, 0) | 67. (540, 120, 0) | 91. (720, 120, 0) |
| 20. (180, 120, 5) | 44. (360, 120, 7) | 68. (540, 120, 7) | 92. (720, 120, 5) |
| 21. (180, 80, 5) | 45. (360, 80, 7) | 69. (540, 80, 7) | 93. (720, 80, 5) |
| 22. (140, 80, 5) | 46. (320, 80, 7) | 70. (500, 80, 7) | 94. (680, 80, 5) |
| 23. (140, 120, 5) | 47. (320, 120, 7) | 71. (500, 120, 7) | 95. (680, 120, 5) |
| 24. (140, 120, 0) | 48. (320, 120, 0) | 72. (500, 120, 0) | 96. (680, 120, 0) |

| #12 | #15 | #18 | #21 |
|---|---|---|---|
| 97 (740, 80, 0) | 121 (200, 140, 0) | 145 (380, 140, 0) | 169 (560, 140, 0) |
| 98 (780, 80, 0) | 122 (340, 140, 0) | 146 (420, 140, 0) | 170 (600, 140, 0) |
| 99 (780, 120, 0) | 123 (340, 180, 0) | 147 (420, 180, 0) | 171 (600, 180, 0) |
| 100 (780, 180, 5) | 124 (340, 180, 6) | 148 (420, 180, 7) | 172 (600, 180, 6) |
| 101 (780, 80, 5) | 125 (340, 140, 6) | 149 (420, 140, 7) | 173 (600, 140, 6) |
| 102 (740, 80, 5) | 126 (200, 140, 6) | 150 (380, 140, 7) | 174 (560, 140, 6) |
| 103 (740, 120, 5) | 127 (200, 180, 6) | 151 (380, 180, 7) | 175 (560, 180, 6) |
| 104 (740, 120, 5) | 128 (200, 180, 0) | 152 (380, 180, 0) | 176 (560, 180, 0) |
| Row 2 #13 | #16 | #19 | #22 |
| 105 (80, 140, 0) | 129 (260, 140, 0) | 153 (440, 140, 0) | 177 (620, 140, 6) |
| 106 (120, 140, 0) | 130 (300, 140, 0) | 154 (480, 140, 0) | 178 (660, 140, 0) |
| 107 (120, 180, 0) | 131 (300, 180, 0) | 155 (480, 180, 0) | 179 (660, 180, 0) |
| 108 (120, 180, 5) | 132 (300, 180, 6) | 156 (480, 180, 7) | 180 (660, 180, 6) |
| 109 (120, 140, 5) | 133 (300, 140, 6) | 157 (480, 140, 7) | 181 (660, 140, 6) |
| 110 (60, 140, 5) | 134 (260, 140, 6) | 158 (440, 140, 7) | 182 (620, 140, 6) |
| 111 (60, 180, 5) | 135 (260, 180, 6) | 159 (440, 180, 7) | 183 (620, 180, 6) |
| 112 (80, 180, 0) | 136 (260, 180, 0) | 160 (440, 180, 0) | 184 (620, 180, 0) |
| #14 | #17 | #20 | #23 |
| 113 (140, 140, 0) | 137 (320, 140, 0) | 161 (500, 140, 0) | 185 (660, 140, 0) |
| 114 (160, 140, 0) | 138 (360, 140, 0) | 162 (540, 140, 0) | 186 (720, 140, 0) |
| 115 (180, 180, 0) | 139 (360, 180, 0) | 165 (540, 180, 0) | 187 (720, 180, 0) |
| 116 (180, 180, 5) | 140 (360, 180, 7) | 164 (540, 180, 7) | 188 (720, 180, 5) |
| 117 (160, 140, 5) | 141 (360, 140, 7) | 165 (540, 140, 7) | 189 (720, 140, 5) |
| 118 (140, 140, 5) | 142 (320, 140, 7) | 166 (500, 140, 7) | 190 (680, 140, 5) |
| 119 (140, 180, 5) | 143 (320, 180, 7) | 167 (500, 180, 7) | 191 (680, 180, 5) |
| 120 (140, 180, 0) | 144 (320, 180, 0) | 168 (500, 180, 0) | 192 (680, 180, 0) |

#24

193 (740, 140, 0)
194 (780, 140, 0)
195 (780, 180, 0)
196 (780, 180, 5)
197 (780, 140, 5)
198 (740, 140, 5)
199 (740, 180, 5)
200 (740, 180, 0)

#29

217 (200, 200, 0)
218 (240, 200, 0)
219 (240, 240, 0)
220 (240, 240, 6)
221 (240, 200, 6)
222 (200, 200, 6)
223 (200, 240, 6)
224 (200, 240, 0)

#80

241 (380, 200, 0)
242 (420, 200, 0)
243 (420, 240, 0)
244 (420, 240, 7)
245 (420, 200, 7)
246 (380, 200, 7)
247 (380, 240, 7)
248 (380, 240, 0)

Row 3 #25

201 (80, 200, 0)
202 (120, 200, 0)
203 (120, 240, 0)
204 (120, 240, 5)
205 (120, 200, 5)
206 (80, 200, 5)
207 (80, 240, 5)
208 (80, 240, 0)

#28

225 (260, 200, 0)
226 (300, 200, 0)
227 (300, 240, 0)
228 (300, 240, 6)
229 (300, 200, 6)
230 (260, 200, 6)
231 (260, 240, 6)
232 (260, 240, 0)

#31

249 (440, 200, 0)
250 (480, 200, 0)
251 (480, 240, 0)
252 (480, 240, 7)
253 (480, 200, 7)
254 (440, 200, 7)
255 (440, 240, 7)
256 (440, 240, 0)

#26

209 (140, 200, 0)
210 (180, 200, 0)
211 (180, 240, 0)
212 (180, 240, 5)
213 (180, 200, 5)
214 (140, 200, 5)
215 (140, 240, 5)
216 (140, 240 0)

#29

233 (320, 200, 6)
234 (360, 200, 0)
235 (360, 240, 0)
236 (360, 240, 7)
237 (360, 200, 7)
238 (320, 200, 7)
239 (320, 240, 7)
240 (320, 240, 6)

#32

257 (500, 200, 0)
258 (540, 200, 0)
259 (540, 240, 0)
260 (540, 240, 7)
261 (540, 200, 7)
262 (500, 200, 7)
263 (500, 240, 7)
264 (500, 240, 0)

| #33 | #36 | #39 |
|---|---|---|
| 265 (560, 200, 0) | 289 (740, 200, 0) | 313 (200, 260, 0) |
| 266 (600, 200, 0) | 290 (780, 200, 0) | 314 (240, 260, 0) |
| 267 (600, 240, 0) | 291 (780, 240, 0) | 315 (240, 300, 0) |
| 268 (600, 240, 6) | 292 (780, 240, 5) | 316 (240, 300, 6) |
| 269 (600, 200, 6) | 293 (780, 200, 5) | 317 (240, 260, 6) |
| 270 (560, 200, 6) | 294 (740, 200, 5) | 318 (200, 260, 6) |
| 271 (560, 240, 6) | 295 (740, 240, 5) | 319 (200, 300, 6) |
| 272 (560, 240, 0) | 296 (740, 240 0) | 320 (200, 300, 0) |

| #34 | ROW 4 #37 | #40 |
|---|---|---|
| 273 (620, 200, 0) | 297 (80, 260, 0) | 321 (260, 260, 0) |
| 274 (660, 200, 0) | 298 (120, 260, 0) | 322 (300, 260, 0) |
| 275 (660, 240, 0) | 299 (120, 300, 0) | 323 (300, 300, 0) |
| 276 (660, 240, 6) | 300 (120, 300, 5) | 324 (300, 300, 6) |
| 277 (660, 200, 6) | 301 (120, 260, 5) | 325 (300, 260, 6) |
| 278 (620, 200, 6) | 302 (80, 260, 5) | 326 (260, 260, 6) |
| 279 (620, 240, 6) | 303 (80, 300, 5) | 327 (260, 300, 6) |
| 280 (620, 240, 0) | 304 (80, 300, 0) | 328 (260, 300, 0) |

| #35 | #38 | #41 |
|---|---|---|
| 281 (680, 200, 0) | 305 (140, 260, 0) | 329 (320, 260, 0) |
| 282 (720, 200, 0) | 306 (180, 260, 0) | 330 (360, 260, 0) |
| 283 (720, 240, 0) | 307 (180, 300, 0) | 331 (360, 300, 0) |
| 284 (720, 240, 5) | 308 (180, 300, 5) | 332 (360, 300, 7) |
| 285 (720, 200, 5) | 309 (180, 260, 5) | 333 (360, 260, 7) |
| 286 (680, 200, 5) | 310 (140, 260, 5) | 334 (320, 260, 7) |
| 287 (680, 240, 5) | 311 (140, 300, 5) | 335 (320, 300, 7) |
| 288 (680, 240 0) | 312 (140, 300, 0) | 336 (320, 300, 0) |

## #42

339 (380, 260, 0)
338 (420, 260, 0)
339 (420, 300, 0)
340 (420, 300, 7)
341 (420, 260, 7)
342 (380, 260, 7)
343 (380, 300, 7)
344 (380, 300, 0)

## #43

345 (440, 260, 0)
346 (480, 260, 0)
347 (480, 300, 0)
348 (480, 300, 7)
349 (480, 260, 7)
350 (440, 260, 7)
351 (440, 300, 7)
352 (440, 300, 0)

## #44

353 (500, 260, 0)
354 (540, 260, 0)
355 (540, 300, 0)
356 (540, 300, 7)
357 (540, 260, 7)
358 (500, 260, 7)
359 (500, 300, 7)
360 (500, 300, 0)

## #45

361 (560, 260, 0)
362 (600, 260, 0)
363 (600, 300, 0)
364 (600, 300, 6)
365 (600, 260, 6)
366 (560, 260, 6)
367 (560, 300, 6)
368 (560, 300, 0)

## #46

369 (620, 260, 0)
370 (660, 260, 0)
371 (660, 300, 0)
372 (660, 300, 6)
373 (660, 260, 6)
374 (620, 260, 6)
375 (620, 300, 6)
376 (620, 300, 0)

## #47

377 (680, 260, 0)
378 (720, 260, 6)
379 (720, 300, 0)
380 (720, 300, 5)
381 (720, 260, 5)
382 (680, 260, 5)
383 (680, 300, 5)
384 (680, 300, 0)

## #48

385 (740, 260, 0)
386 (780, 260, 0)
387 (780, 300, 0)
388 (780, 300, 5)
389 (780, 260, 5)
390 (740, 260, 5)
391 (740, 300, 5)
392 (740, 300, 0)

## Rows #49

393 (80, 320, 0)
394 (120, 320, 0)
395 (120, 360, 0)
396 (120, 360, 5)
397 (120, 320, 5)
398 (80, 320, 5)
399 (80, 360, 5)
400 (80, 360, 0)

## #50

401 (140, 320, 0
402 (180, 320, 0
403 (180, 360, 0
404 (180, 360, 5
405 (180, 320, 5
406 (140, 320, 5
407 (140, 360, 5
408 (140, 360, 0

| #51 | #54 | #57 |
|---|---|---|
| 409 (200, 320, 0) | 433 (380, 320, 0) | 457 (560, 320, 0) |
| 410 (240, 320, 0) | 434 (420, 320, 0) | 458 (600, 320, 0) |
| 411 (240, 360, 0) | 435 (420, 360, 0) | 459 (600, 360, 6) |
| 412 (240, 360, 6) | 436 (480, 360, 7) | 460 (600, 360, 6) |
| 413 (240, 320, 6) | 437 (420, 320, 7) | 461 (600, 380, 6) |
| 414 (200, 320, 6) | 438 (380, 320, 7) | 462 (560, 320, 6) |
| 415 (200, 360, 6) | 439 (380, 360, 7) | 463 (560, 360, 6) |
| 416 (200, 360, 0) | 440 (380, 360, 6) | 464 (560, 360, 0) |
| #52 | #55 | #58 |
| 417 (200, 320, 0) | 441 (440, 320, 6) | 465 (620, 320, 0) |
| 418 (300, 320, 0) | 442 (480, 320, 0) | 466 (660, 320, 0) |
| 419 (300, 360, 0) | 443 (480, 360, 0) | 467 (660, 360, 6) |
| 420 (300, 360, 6) | 444 (480, 360, 7) | 468 (660, 360, 6) |
| 421 (300, 320, 6) | 445 (480, 320, 7) | 469 (660, 320, 6) |
| 422 (260, 320, 6) | 446 (440, 320, 7) | 470 (620, 320, 6) |
| 423 (260, 360, 6) | 447 (440, 360, 7) | 471 (620, 360, 6) |
| 424 (260, 360, 0) | 448 (440, 360, 0) | 472 (620, 360, 0) |
| #53 | #56 | #59 |
| 425 (380, 380, 0) | 449 (500, 320, 0) | 473 (680, 320, 0) |
| 426 (360, 320, 0) | 450 (540, 320, 0) | 474 (720, 320, 0) |
| 427 (360, 360, 0) | 451 (540, 360, 0) | 475 (720, 360, 0) |
| 428 (360, 360, 7) | 452 (540, 360, 7) | 476 (720, 360, 5) |
| 429 (360, 320, 7) | 453 (540, 320, 7) | 477 (720, 320, 5) |
| 430 (320, 320, 7) | 454 (500, 320, 7) | 478 (680, 320, 5) |
| 431 (320, 360, 7) | 455 (500, 360, 7) | 479 (680, 360, 5) |
| 432 (320, 360, 0) | 456 (500, 360, 0) | 480 (680, 360, 0) |

Start Here

#60

481 (740, 320, 0)
482 (780, 320, 0)
483 (780, 360, 0)
484 (780, 360, 5)
485 (780, 320, 5)
486 (740, 320, 5)
487 (740, 360, 5)
488 (740, 360, 0)

Row 6 #61

489 (80, 360, 0)
490 (120, 360, 0)
491 (120, 420, 0)
492 (120, 420, 5)
493 (120, 380, 5)
494 (80, 380, 5)
495 (80, 420, 5)
496 (80, 420, 0)
497 (140, 380, 0) #62
498 (180, 380, 0)
499 (160, 420, 0)
500 (160, 420, 5)
501 (160, 380, 5)
502 (140, 380, 5)
503 (140, 420, 5)
504 (140, 420, 0)

#63

505 (200, 380, 0)
506 (240, 380, 0)
507 (240, 420, 0)
508 (240, 420, 6)
509 (240, 380, 6)
510 (200, 380, 6)
511 (200, 420, 6)
512 (200, 420, 0)
513 (260, 380, 0)
514 (300, 380, 0)
515 (300, 420, 0)
516 (300, 420, 6)
517 (260, 380, 6)
518 (260, 380, 6)
519 (260, 420, 6)
520 (260, 420, 0)
521 (320, 380, 0)
522 (360, 380, 0)
523 (360, 420, 0)
524 (360, 420, 7)
525 (360, 380, 7)
526 (320, 380, 7)
527 (360, 420, 7)
528 (320, 420, 0)

529 (360, 380, 6)
530 (400, 380, 6)
531 (400, 420, 6)
532 (400, 420, 7)
533 (400, 360, 7)
534 (360, 360, 7)
535 (360, 420, 7)
536 (360, 420, 0)
537 (440, 360, 0)
538 (480, 380, 0)
539 (480, 420, 0)
540 (480, 420, 7)
541 (480, 380, 7)
542 (440, 360, 7)
543 (440, 420, 7)
544 (440, 420, 0)
545 (500, 380, 0)
546 (500, 380, 0)
547 (500, 420, 6)
548 (500, 420, 7)
549 (500, 380, 7)
560 (500, 360, 7)
551 (500, 420, 7)
552 (500, 420, 7)

| | | |
|---|---|---|
| (560, 380, 6) | (740, 380, 0) | (260, 446, 0) |
| (600, 380, 0) | (780, 380, 0) | (240, 440, 0) |
| (600, 420, 0) | (780, 420, 0) | (240, 480, 0) |
| (600, 420, 6) | (780, 420, 5) | (240, 480, 6) |
| (600, 380, 6) | (780, 380, 5) | (240, 440, 6) |
| (560, 360, 6) | (740, 380, 5) | (200, 480, 6) |
| (560, 420, 6) | (740, 420, 5) | (200, 480, 6) |
| (560, 420, 0) | (740, 420, 0) | (200, 480, 0) |
| (600, 380, 0) | (80, 440, 0) | (260, 440, 0) |
| (660, 380, 0) | (100, 440, 0) | (300, 440, 0) |
| (660, 480, 0) | (120, 480, 0) | (300, 480, 0) |
| (660, 420, 6) | (120, 480, 5) | (300, 480, 6) |
| (660, 380, 6) | (120, 440, 5) | (300, 440, 6) |
| (620, 380, 6) | (80, 440, 5) | (260, 440, 6) |
| (620, 420, 6) | (80, 480, 5) | (260, 480, 6) |
| (620, 420, 0) | (80, 480, 0) | (260, 480, 0) |
| (660, 380, 0) | (140, 440, 0) | (320, 440, 0) |
| (720, 380, 0) | (180, 440, 0) | (360, 440, 0) |
| (720, 420, 0) | (180, 480, 0) | (360, 480, 0) |
| (720, 420, 5) | (180, 480, 5) | (360, 480, 7) |
| (720, 380, 5) | (180, 440, 5) | (360, 440, 7) |
| (680, 380, 5) | (140, 440, 5) | (300, 440, 7) |
| (680, 420, 5) | (140, 480, 5) | (300, 480, 7) |
| (660, 420, 0) | (140, 480, 0) | (320, 480, 0) |

(380, 446, 0)
(420, 446, 0)
(420, 480, 0)
(420, 480, 7)
(420, 446, 7)
(380, 446, 7)
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(500, 446, 6)
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(560, 440, 0)
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(680, 440, 0)
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(740, 440, 0)
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(80, 500, 0)
(120, 500, 0)
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(140, 500, 0)
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(140, 540, 5)
(140, 540, 0)

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| | | |
|---|---|---|
| (200, 500, 0) | (380, 500, 0) | (560, 500, 0) |
| (240, 500, 0) | (420, 500, 0) | (600, 500, 0) |
| (240, 540, 0) | (420, 540, 0) | (600, 540, 0) |
| (240, 540, 6) | (420, 540, 7) | (600, 540, 6) |
| (240, 500, 6) | (420, 500, 7) | (600, 500, 6) |
| (200, 500, 6) | (380, 500, 7) | (560, 500, 6) |
| (200, 540, 6) | (380, 540, 7) | (560, 540, 6) |
| (200, 540, 0) | (380, 540, 0) | (560, 540, 0) |
| (260, 500, 0) | (440, 500, 0) | (620, 500, 0) |
| (300, 500, 0) | (480, 500, 0) | (660, 500, 0) |
| (300, 540, 0) | (480, 540, 0) | (660, 540, 0) |
| (300, 540, 6) | (480, 540, 7) | (660, 540, 6) |
| (300, 500, 6) | (480, 500, 7) | (660, 500, 6) |
| (260, 500, 6) | (440, 500, 7) | (620, 500, 6) |
| (260, 540, 6) | (440, 540, 7) | (620, 540, 6) |
| (260, 540, 0) | (440, 540, 0) | (620, 540, 0) |
| (320, 500, 0) | (500, 500, 0) | (680, 500, 0) |
| (360, 500, 0) | (540, 500, 0) | (720, 500, 0) |
| (360, 540, 0) | (540, 540, 0) | (720, 540, 0) |
| (360, 540, 7) | (540, 540, 7) | (720, 540, 5) |
| (360, 500, 7) | (540, 500, 7) | (720, 500, 5) |
| (320, 500, 7) | (500, 500, 7) | (680, 500, 5) |
| (320, 540, 7) | (500, 540, 7) | (680, 540, 5) |
| (320, 540, 0) | (500, 540, 0) | (680, 540, 0) |

(740, 500, 6) (200, 560, 0) (380, 560, 0)
(780, 500, 0) (240, 560, 0) (420, 560, 0)
(780, 540, 0) (240, 600, 6) (420, 600, 0)
(780, 540, 5) (240, 600, 6) (420, 600, 7)
(780, 500, 5) (240, 560, 6) (420, 560, 7)
(740, 500, 5) (200, 560, 6) (380, 560, 7)
(740, 540, 5) (200, 600, 6) (380, 600, 7)
(740, 540, 0) (200, 600, 0) (380, 600, 0)
(R9) (80, 560, 0) (260, 560, 0) (440, 560, 0)
(120, 600, 0) (300, 560, 6) (480, 560, 0)
(120, 600, 0) (300, 600, 0) (480, 600, 0)
(120, 600, 5) (300, 600, 6) (480, 600, 7)
(120, 600, 5) (300, 560, 6) (480, 560, 7)
(80, 560, 5) (260, 560, 6) (440, 560, 7)
(80, 560, 5) (260, 600, 6) (440, 600, 7)
(80, 560, 0) (260, 600, 0) (440, 600, 0)
(140, 560, 0) (320, 560, 0) (500, 560, 0)
(160, 560, 0) (360, 560, 0) (540, 560, 0)
(160, 600, 0) (360, 600, 0) (540, 600, 0)
(160, 600, 5) (360, 600, 7) (540, 600, 7)
(160, 560, 5) (360, 560, 7) (540, 560, 7)
(140, 560, 5) (320, 560, 7) (500, 560, 7)
(140, 600, 5) (320, 600, 7) (500, 600, 7)
(140, 600, 0) (320, 600, 0) (500, 600, 0)

(560, 560, 0)
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(740, 560, 0)
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(740, 600, 0)
R10 (80, 620, 0)
(120, 600, 0)
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(120, 620, 5)
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(80, 660, 5)
(80, 660, 0)
(140, 620, 0)
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(140, 660, 0)

(200, 620, 0)
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(200, 660, 6)
(200, 660, 0)
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(300, 620, 0)
(300, 660, 0)
(300, 660, 6)
(300, 620, 6)
(260, 620, 6)
(260, 660, 6)
(260, 660, 0)
(320, 620, 0)
(360, 620, 0)
(360, 660, 0)
(360, 660, 7)
(360, 620, 7)
(320, 620, 7)
(320, 660, 7)
(320, 660, 0)

| | | |
|---|---|---|
| (360, 620, 0) | (560, 620, 0) | (740, 620, 0) |
| (400, 680, 0) | (600, 626, 0) | (780, 620, 0) |
| (420, 660, 0) | (600, 666, 0) | (780, 660, 0) |
| (420, 660, 7) | (600, 660, 6) | (780, 660, 5) |
| (420, 620, 7) | (600, 620, 6) | (780, 620, 5) |
| (380, 620, 7) | (560, 620, 6) | (740, 626, 5) |
| (380, 660, 7) | (560, 660, 6) | (740, 660, 5) |
| (380, 660, 0) | (560, 660, 0) | (740, 660, 0) |
| (440, 620, 0) | (620, 620, 0) | (R11) (80, 680, 0) |
| (450, 620, 0) | (660, 620, 0) | (120, 680, 0) |
| (480, 660, 0) | (660, 660, 0) | (120, 720, 0) |
| (480, 660, 7) | (660, 660, 6) | (120, 720, 5) |
| (480, 620, 7) | (660, 620, 6) | (120, 680, 5) |
| (440, 680, 7) | (620, 620, 6) | (80, 680, 5) |
| (440, 660, 7) | (620, 660, 6) | (80, 720, 5) |
| (440, 660, 0) | (620, 660, 0) | (80, 720, 0) |
| (500, 620, 0) | (680, 620, 0) | (140, 680, 0) |
| (540, 620, 0) | (720, 620, 0) | (180, 680, 0) |
| (540, 660, 0) | (720, 660, 0) | (180, 720, 0) |
| (540, 660, 7) | (720, 660, 5) | (180, 720, 5) |
| (540, 620, 7) | (720, 620, 5) | (180, 680, 5) |
| (500, 620, 7) | (680, 620, 5) | (140, 680, 5) |
| (500, 660, 7) | (680, 660, 5) | (140, 720, 5) |
| (500, 660, 0) | (680, 660, 0) | (140, 720, 0) |

| | | |
|---|---|---|
| (200, 680, 0) | (380, 680, 0) | (560, 680, 0) |
| (240, 680, 0) | (420, 680, 0) | (600, 680, 0) |
| (240, 720, 0) | (420, 720, 0) | (600, 720, 0) |
| (240, 720, 6) | (420, 720, 7) | (600, 720, 6) |
| (240, 680, 6) | (420, 680, 7) | (600, 680, 6) |
| (200, 680, 6) | (380, 680, 7) | (560, 680, 6) |
| (200, 720, 6) | (380, 720, 7) | (560, 720, 6) |
| (200, 720, 0) | (380, 720, 0) | (560, 720, 0) |
| (260, 680, 0) | (440, 680, 0) | (620, 680, 0) |
| (300, 680, 0) | (480, 680, 0) | (660, 660, 0) |
| (300, 720, 0) | (480, 720, 0) | (660, 720, 0) |
| (300, 720, 6) | (480, 720, 7) | (660, 720, 6) |
| (300, 680, 6) | (480, 680, 7) | (660, 660, 6) |
| (260, 680, 6) | (440, 680, 7) | (620, 680, 6) |
| (260, 720, 6) | (440, 720, 7) | (620, 720, 6) |
| (260, 720, 0) | (440, 720, 0) | (620, 720, 0) |
| (320, 680, 0) | (500, 680, 0) | (680, 680, 0) |
| (360, 680, 0) | (540, 660, 0) | (720, 680, 0) |
| (360, 720, 0) | (540, 720, 0) | (720, 720, 0) |
| (360, 720, 7) | (540, 720, 7) | (720, 720, 5) |
| (360, 680, 7) | (540, 680, 7) | (720, 680, 5) |
| (320, 680, 7) | (500, 680, 7) | (680, 680, 5) |
| (320, 720, 7) | (500, 720, 7) | (680, 720, 5) |
| (320, 720, 0) | (500, 720, 0) | (680, 720, 0) |

(560, 740, 0)
(600, 740, 0)
(600, 780, 0)
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(680, 780, 5)
(680, 780, 0)

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(740, 740, 5)
(740, 780, 5)
(740, 780, 0)

| | | |
|---|---|---|
| (740, 680, 0) | (800, 740, 0) | (380, 740, 0) |
| (780, 680, 0) | (840, 740, 0) | (420, 740, 0) |
| (780, 720, 0) | (840, 780, 0) | (420, 780, 0) |
| (780, 780, 5) | (840, 780, 6) | (420, 780, 7) |
| (780, 680, 5) | (840, 740, 6) | (420, 740, 7) |
| (740, 680, 5) | (800, 740, 6) | (380, 740, 7) |
| (740, 720, 5) | (800, 780, 6) | (380, 780, 7) |
| (740, 720, 0) | (800, 780, 0) | (380, 780, 0) |
| (86, 740, 0) | (260, 740, 0) | (440, 740, 0) |
| (120, 740, 0) | (300, 740, 0) | (480, 740, 0) |
| (120, 780, 0) | (300, 780, 0) | (480, 780, 0) |
| (120, 780, 5) | (300, 780, 6) | (480, 780, 7) |
| (120, 740, 5) | (300, 740, 6) | (480, 740, 7) |
| (80, 740, 5) | (260, 740, 6) | (440, 740, 7) |
| (80, 780, 5) | (260, 780, 6) | (440, 780, 7) |
| (80, 780, 0) | (260, 780, 0) | (440, 780, 0) |
| (140, 740, 0) | (320, 740, 0) | (500, 740, 0) |
| (180, 740, 0) | (360, 740, 0) | (540, 740, 0) |
| (180, 780, 0) | (360, 780, 0) | (540, 780, 0) |
| (180, 780, 5) | (360, 780, 7) | (540, 780, 7) |
| (180, 740, 5) | (360, 740, 7) | (540, 740, 7) |
| (140, 740, 5) | (320, 740, 7) | (500, 740, 7) |
| (140, 780, 5) | (320, 780, 7) | (500, 780, 7) |
| (140, 780, 0) | (320, 780, 0) | (500, 780, 0) |

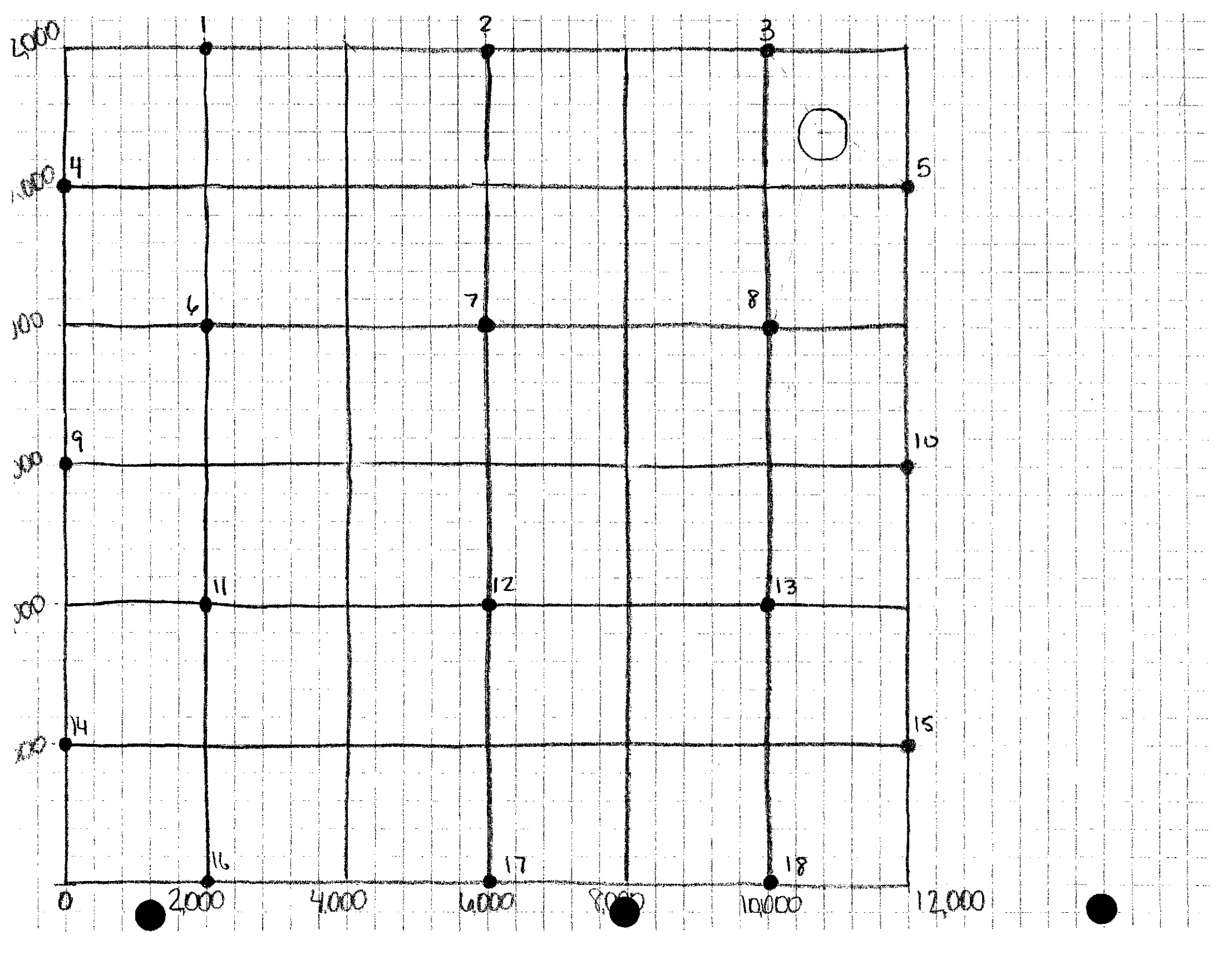
R12

Land track

Polygonal method

Triangulation

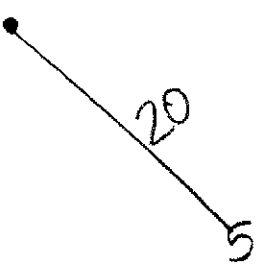
Inverse distance to a square


4,000
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
0
2,000
4,000
6,000
8,000
10,000
12,000

| Drill Hole | Seam Thickness | East Coordinate | North Coordinate |
|---|---|---|---|
| 1 | 4.6 | 2000 | 12000 |
| 2 | 6.1 | 6000 | 12000 |
| 3 | 5.5 | 10000 | 12000 |
| 4 | 5.9 | 0 | 10000 |
| 5 | 5.1 | 12000 | 10000 |
| 6 | 6.3 | 2000 | 8000 |
| 7 | 5.2 | 6000 | 8000 |
| 8 | 4.7 | 10000 | 8000 |
| 9 | 5.8 | 0 | 6000 |
| 10 | 5.3 | 12000 | 6000 |
| 11 | 6.2 | 2000 | 4000 |
| 12 | 5.6 | 6000 | 4000 |
| 13 | 6.4 | 10000 | 4000 |
| 14 | 5.1 | 0 | 2000 |
| 15 | 5.7 | 12000 | 2000 |
| 16 | 4.9 | 2000 | 0 |
| 17 | 5.3 | 6000 | 0 |
| 18 | 6.2 | 1000 | 0 |

2

3



$d = \sqrt{(10000-10800)^2 + (8000-10800)^2}$

$d = \sqrt{(-800)^2 + (-2800)^2}$

$d = \sqrt{640000 + 7840000}$

$d = \sqrt{8480000}$

$d = 2912.04$

$(10,800, 10,800)$ $(x_1, y_1)$ $(10000, 8000)$ $(x_2, y_2)$

1442.22 = dH #5

4947.73 = dH #2

1442.22 = dH #3

2912.04 = dH #8

4947.73 dH #10

$d = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$

$d = \sqrt{(10,800-6000)^2 + (10,800-12000)^2}$

$d = \sqrt{(4800)^2 + (-1200)^2}$

$d = \sqrt{23040000 + 1440000}$

$d = \sqrt{24480000}$

$d = 4947.73$

$(6000, 12000)$ $(x_1, y_1)$

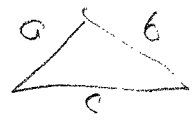
$(10,800, 10,800)$ $(x_2, y_2)$

2: 6000, 12000 - 4647.58

10,800, 10,800

12000, 6000

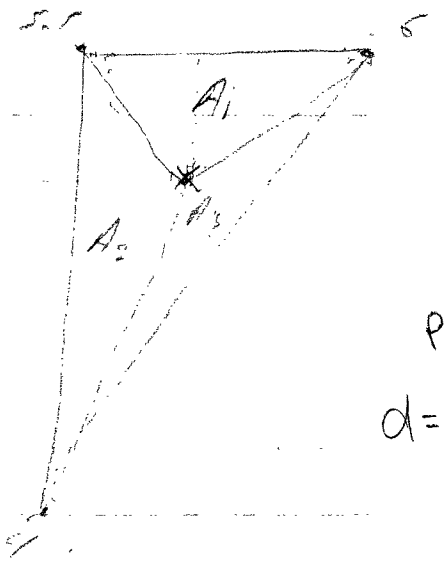
$A = \frac{1}{2}bh$




Heron's Formula

$A = \sqrt{s(s-a)(s-b)(s-c)}$

$s = \frac{1}{2}(a+b+c)$




point 5 to point 3

③ 10000, 12000

⑤ 12000, 10000

$d = \sqrt{(12000-10000)^2 + (10000-12000)^2}$

$(2000)^2 + (-2000)^2$

$4000000 + 4000000$

$d = \sqrt{8000000}$

$d = 2828.4271$

point 5 to point 8

⑤ 12000, 10000

⑧ 10000, 8000

$d = \sqrt{(10000-12000)^2 + (8000-10000)^2}$

$(-2000)^2 + (-2000)^2$

$4000000 + 4000000$

$d = \sqrt{8000000}$

$d = 2828.4271$

point 8 to point 3

point 8 10000, 8000

point 3 10000, 12000

$d = \sqrt{(10000-10000)^2 + (12000-8000)^2}$

$(0)^2 + (4000)^2$

$d = \sqrt{16000000}$

$d = 4000$

$S = \frac{1}{2}(4000 + 2912.04 + 1442.22)$

$S = 4177.13$

2,559,968,233,000.0

## Triangle 2

$A = \sqrt{4177.13(4177.13 - 4000)(4177.13 - 2912.04)(4177.13 - 1442.}$

$A = 1,599,990.07$

$S = \frac{1}{2}(2828.43 + 1442.22 + 1442.22)$

$S = 2856.44$

160,019,225,600.2

## Triangle 3

$A = \sqrt{2856.44(2856.44 - 2828.43)(2856.44 - 1442.22)(2856.44 - 1442.2}$

$A = 400024.03$

## Areas

T#1 = 2,000,017.12

T#2 = 1,599,990.07

T#3 = 400,024.03

$$\frac{p3 \times A\#1 + p8 \times A\#3 + p5 \times A\#2}{\text{A of 3 triangles}}$$

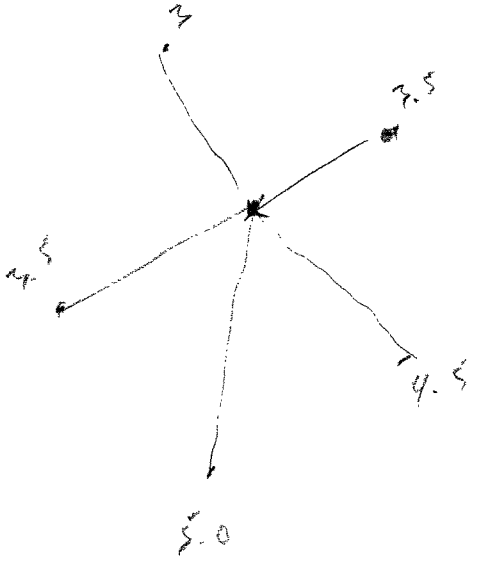
$$\frac{5.5(2000017.12) + 4.7(400024.03) + 5.1(1599990.07)}{4,000,031.22}$$

$$\frac{21040156.46}{4000031.22}$$

estimated height = 5.25999

Inverse distance to a square

$$d = \sqrt{(x_0 - x_1)^2 + (y_0 - y_1)^2}$$




5 - 12,000 , 10,000
10,800 , 10,800

$$d = \sqrt{(12{,}000 - 10{,}800)^2 + (10{,}000 - 10{,}800)^2}$$

$$(1200)^2 + (-800)^2$$

$$34.6 + -28.3$$

$$d = 6.3$$

1,440,000 -640,000

894.43

Point 3 (2)
(10,000 , 12,000) (10,800 , 10,800) (1)

$$d = \sqrt{(10{,}000 - 10{,}800)^2 + 12}$$

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$d = \sqrt{(10{,}800 - 10{,}000)^2 + (10{,}810 - 12{,}000)^2}$$

$$(800)^2 + (-1200)^2$$

Point 3 $\quad (10{,}000, 12{,}000) \quad (10{,}800, 10{,}800)$

$$d = \sqrt{(10{,}000 - 10{,}800) + (12{,}000 - 10{,}800)}$$

$$(-800)^2 + (1200)^2$$

$$-640{,}000 + 1{,}440{,}000$$

$$800{,}000$$

$$894.43$$

1442.22

Point 10 $= (12{,}000, 6{,}000) \quad (10{,}800, 10{,}800)$

$$d = \sqrt{(12{,}000 - 10{,}800) + (6{,}000 - 10{,}800)}$$

$$(1200)^2 + (-4800)^2$$

$$1{,}440{,}000 + 23{,}040{,}000$$

$$\sqrt{24{,}480{,}000} = 4947.73$$

$x + y + \overset{?}{c} = \overset{\text{height}}{z}$

pair 8 $10000a + 8000b + c = 4.7$

pair 3 $10000a + 12000b + c = 5.5$

pair 5 $12000a + 10000b + c = 5.1$

$(-1)\begin{cases} 10000a + 8000b + c = 4.7 \\ 10000a + 12000b + c = 5.5 \end{cases}$

$-10000a - 8000b - c = -4.7$

$10000a + 12000b + c = 5.5$

$4000b = .8$

$b = .0002$

$10000a + 12000b + c = 5.5$

$(-1)\ 12000a + 10000b + c = 5.1$

$10000a + 12000b + c = 5.5$

$-12000a - 10000b - c = -5.1$

$-2000a - 2000b = .4$

$-2000a - 2000(.0002) = .4$

$-2000a - .4 = .4$

$-2000a = .8$

$a = -.0004$

$10000(-.0004) + 8000(.0002) + c = 4.7$

$-4 + 1.6 + c = 4.7$

$-2.4 + c = 4.7$

$c = 7.1$

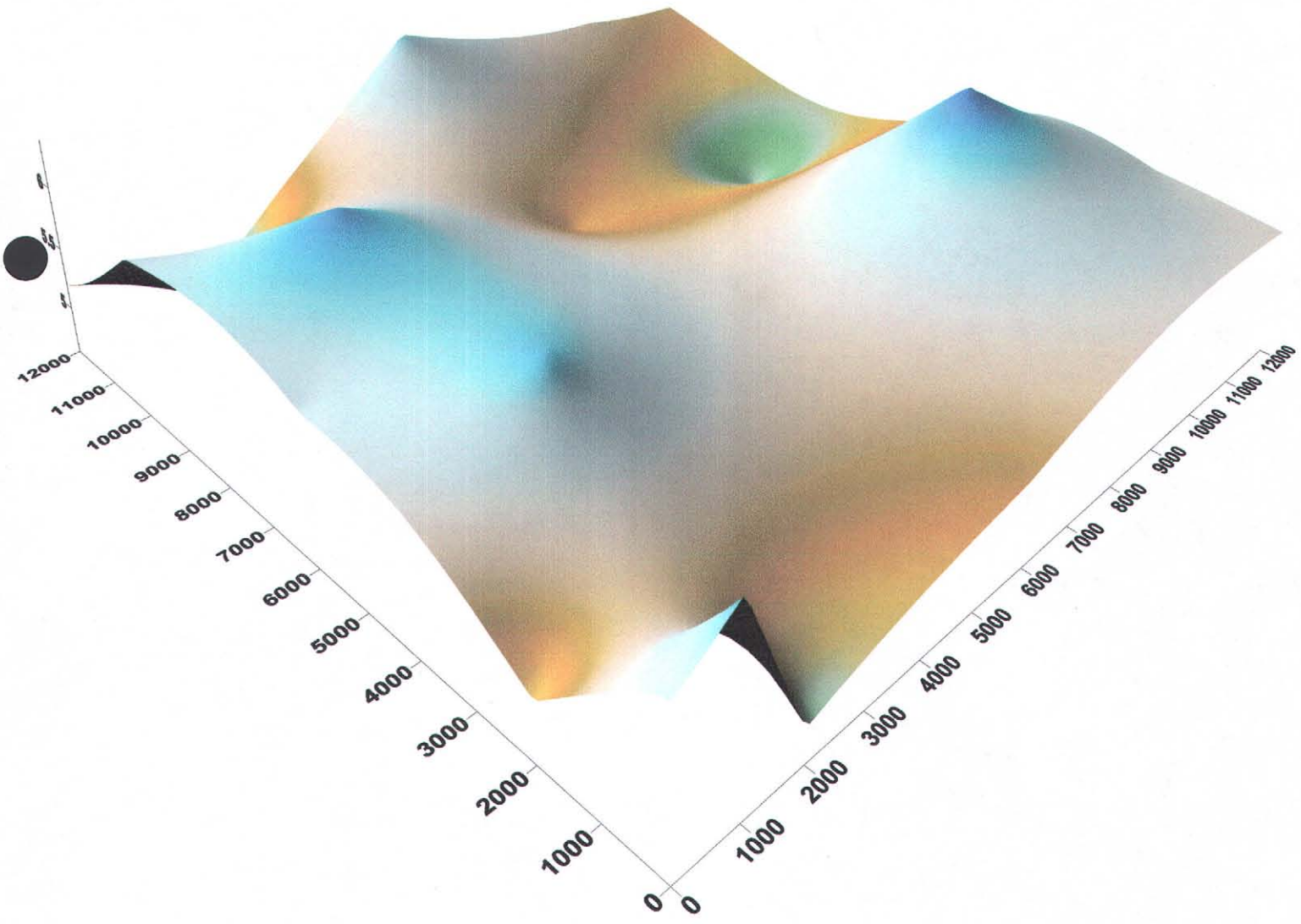
$-.0004x + .0002y + 7.1 = z$

$-.0004(10,800) + .0002(10,800) + 7.1 = z$

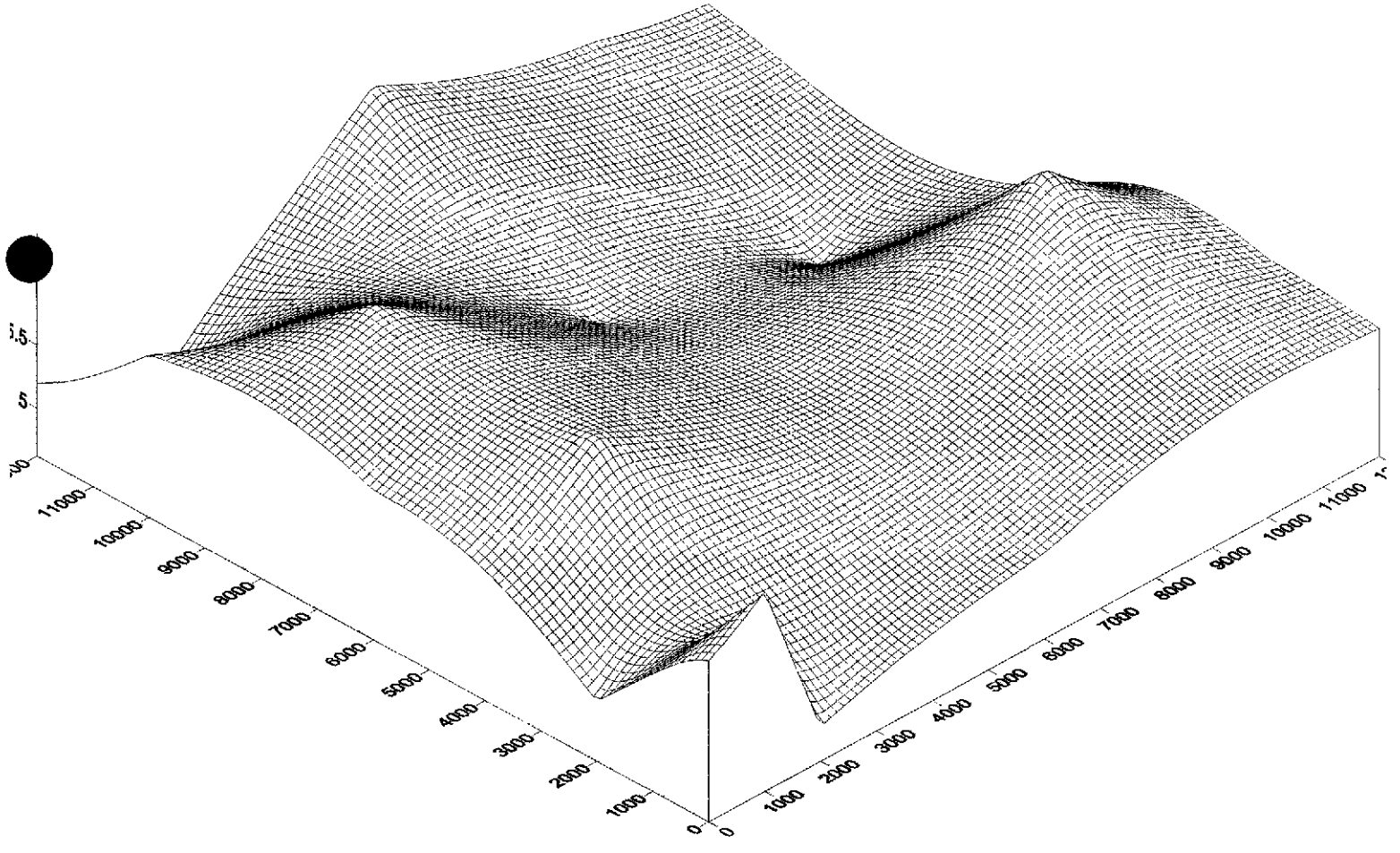
$4.94 \text{ ft} = z$ (ft)

| drill Hole | $d_i$ | $1/d_i^2$ | $w_i$ | $q_i$ | $w_i q_i$ |
|---|---|---|---|---|---|
| 2 | 4947.73 | .000202112 | .0947 | 6.1 | .57767 |
| 3 | 1442.22 | .0006 9337 | .3249 | 5.5 | 1.78695 |
| 5 | 1442.22 | .0006 9337 | .3249 | 5.1 | 1.65699 |
| 8 | 2912.04 | .00034340 | .1609 | 4.7 | .75623 |
| 10 | 4947.73 | .000202112 | .0947 | 5.3 | .50191 |
| Sums | | .002134364 | 1.0001 | | 5.27975 |

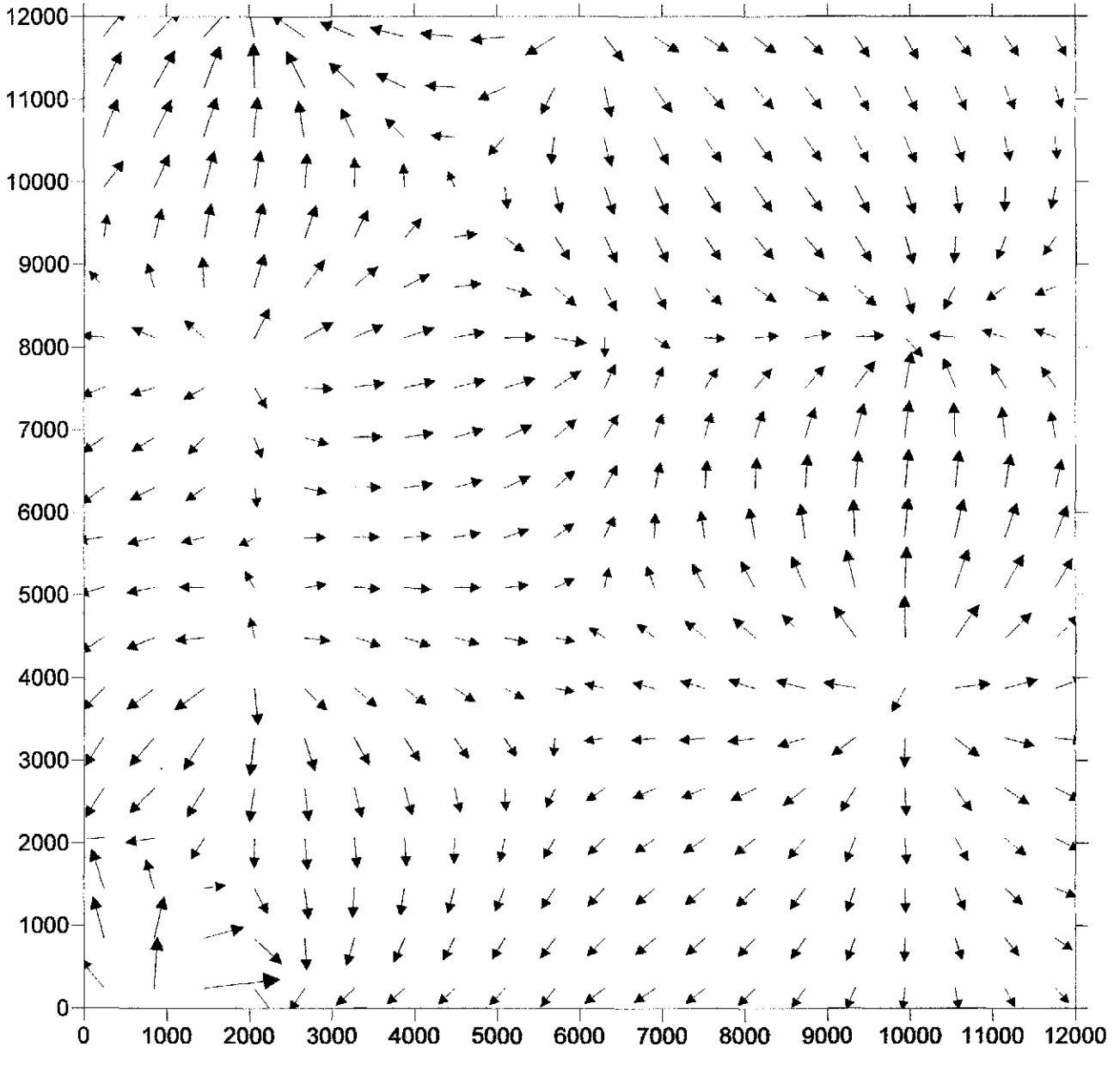
# Surface Map


12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000

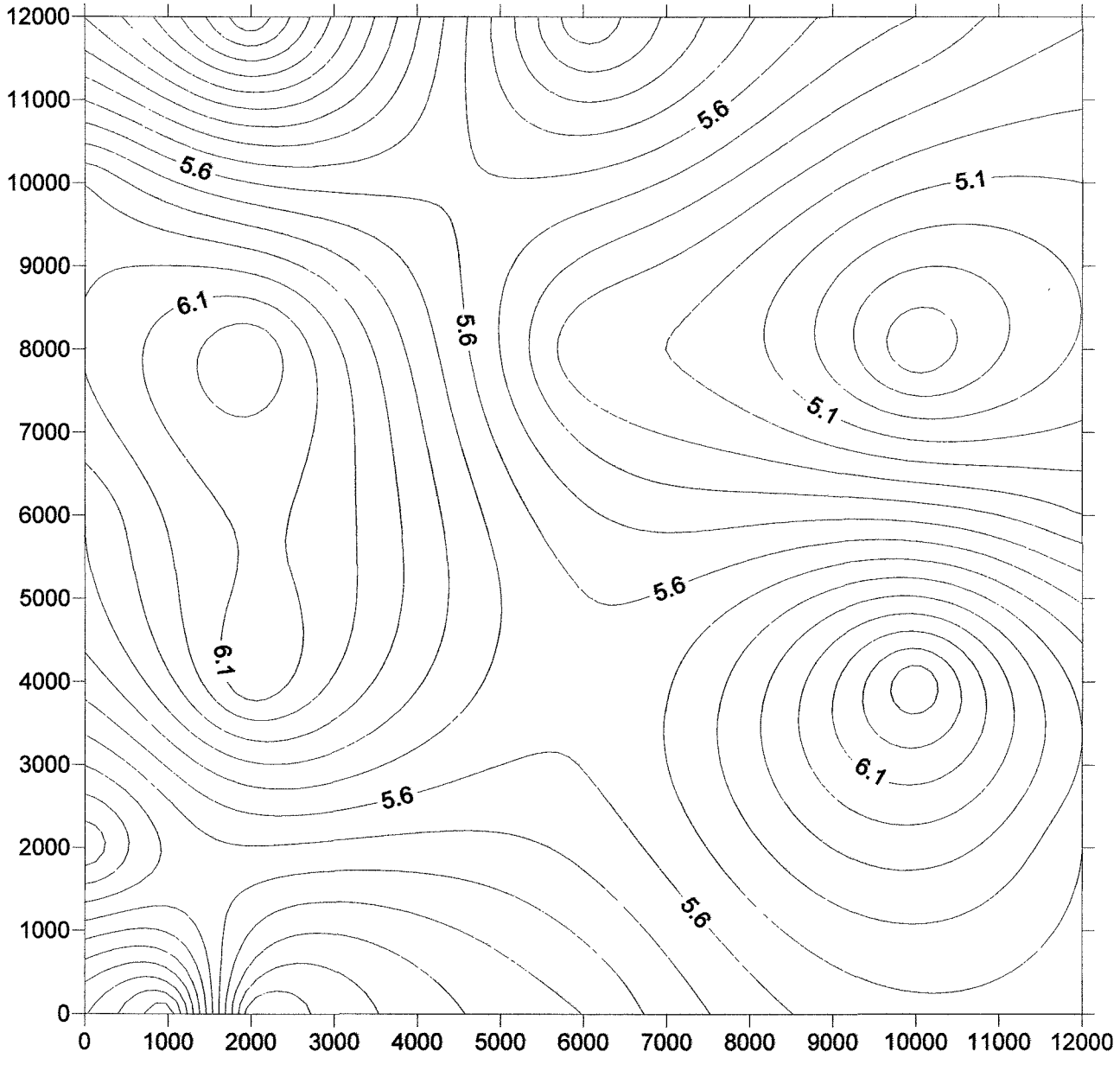
# Wireframe Map



# Vector Map

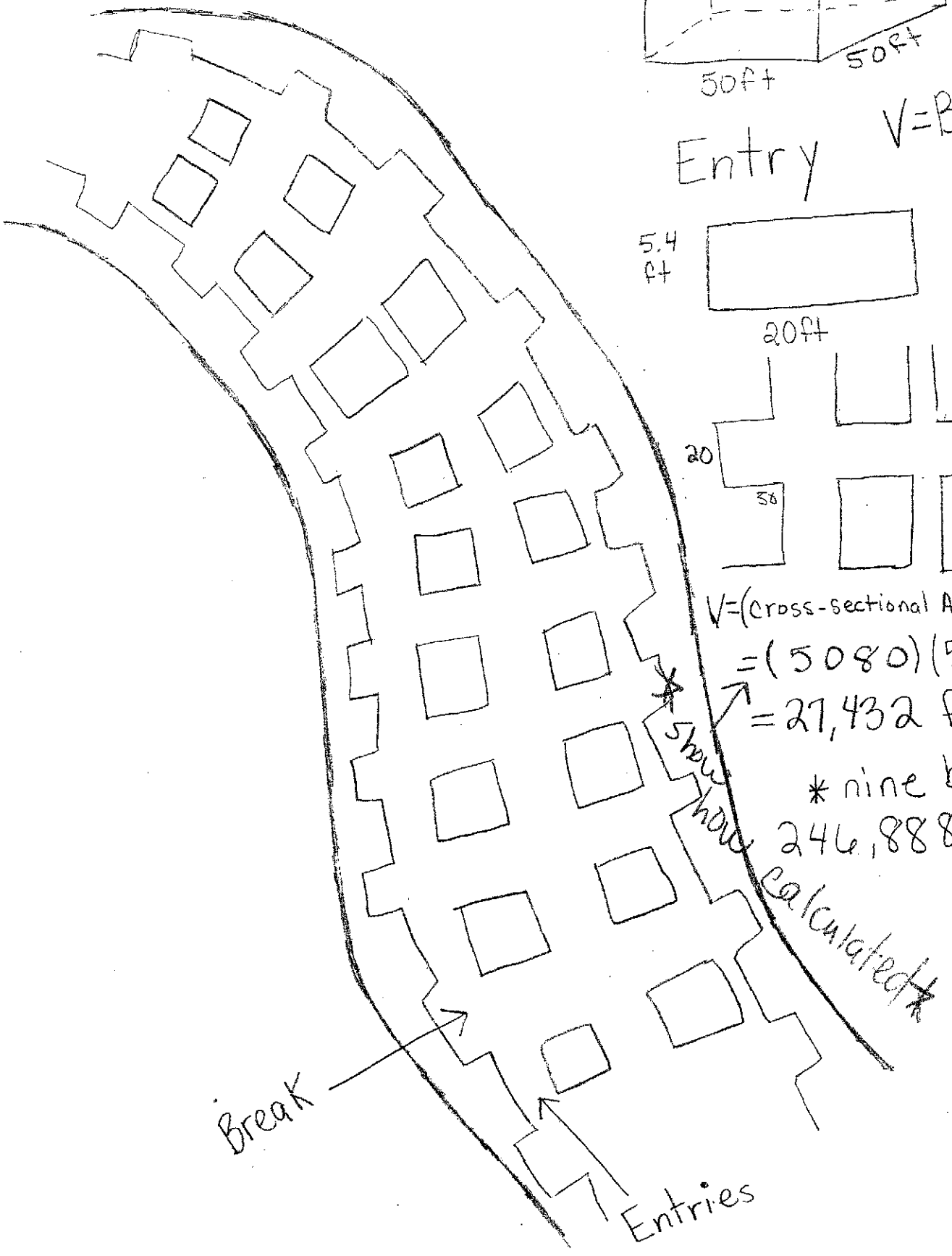

12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000

# Contour Map


12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
5.6
5.6
5.1
6.1
5.6
5.1
5.6
6.1
5.6
6.1
5.6

# Calculus Applications

Mine layout
Fluid force
Work


50ft
50ft
Entry
V=Bh
5.4 ft
20ft
20
30
28
5
V=(Cross-sectional Area)(height)
=(5080)(5.4ft)
=27,432 ft³
* nine breaks
246,888 ft³
* shows how calculated
Break
Entries

# Solutions

1

{ Explanation:
By slanting at a 45° does not create a less fluid force, but rather an equal force }

2. Alternate Plan
"Plan B"
Pumping the Water out of the Mine.

{ Explanation:
If knew the mine needed to be pumped out then this could possibly prevent an underground coal mine blowout }

E]

$$\text{Force} = (\text{Pressure})(\text{Area})$$

$$\text{Fluid Force (FF)} = w\int_a^b (\text{depth} * \text{width}) \, d(\text{depth})$$

$$FF = \frac{62.5\ lbs}{1\ ft^3}\int_a^b (20\ ft)(y\ ft)(dy\ ft)$$

$$= \ldots\ lb$$

Fluid force $= w\int_a^b (\text{depth} * \text{width})$

*NOTE: Fluid density of water $(w) = 62.5 \frac{lb}{ft^3}$.

$= w\int_a^b y\, f(y)\, dy$

$= 62.5 \int_0^{5.4} 20y\, dy$

$62.5 * 20 \left[\frac{y^2}{2}\right]\Big|_0^{5.4}$

$= \left\{62.5 * 20 \left[\frac{(5.4)^2}{2}\right]\right\} - \left\{62.5 * 20 \left[\frac{(0)^2}{2}\right]\right\}$

$= \{18,225\} - \{0\}$

$= \boxed{18,225\ lb}$

Slanting the Coal at an Inclined Surface

$\sin\frac{\pi}{4} \frac{\Delta y}{x}$

$x = \frac{dy}{\sin \pi/4}$

$62.5 \int_0^{5.4} 20\left(\frac{1}{\sin\frac{\pi}{4}}\right) y\, dy =$

$\sin\frac{\pi}{4} = \frac{1}{\frac{\sqrt{2}}{2}} = \frac{2}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}}$

$= \frac{2\sqrt{2}}{2}$

$= \sqrt{2}$

$62.5 \int_0^{5.4} 20\sqrt{2}\, y\, dy =$

$62.5 * 20\sqrt{2} \left[\frac{y^2}{2}\right]\Big|_0^{5.4}$

$= \{25,774.04217\} - \{0\}$

# Vector Analysis

Fluid force is perpendicular to surface.

[x direction Force]

$i \cos(45°)(25{,}774.04217 \text{ lbs}) =$

18,225 lbs in the positive x direction.

[y direction force]

$j \sin(45°)(25{,}774.04217 \text{ lbs}) =$

18,225 in the negative y direction.

For this problem, we do not need the negative y direction.

# Work
overall definition

a.) Work done by a constant force
Work = (Force)(distance)

b.) Work done by a variable force along a straight line.
*NOTE: Object is moved from $x=a$ to $x=b$.

$$\text{Work} = \int_a^b (\text{Force})\,dx =$$

$$\int_a^b (62.5)(\text{area})(28-y)\,dy$$

(Force: $(62.5)(\text{area})$; distance: $(28-y)$)

$$= 62.5 \int_a^b (\text{cross-sectional area})(\text{distance})\,dy$$

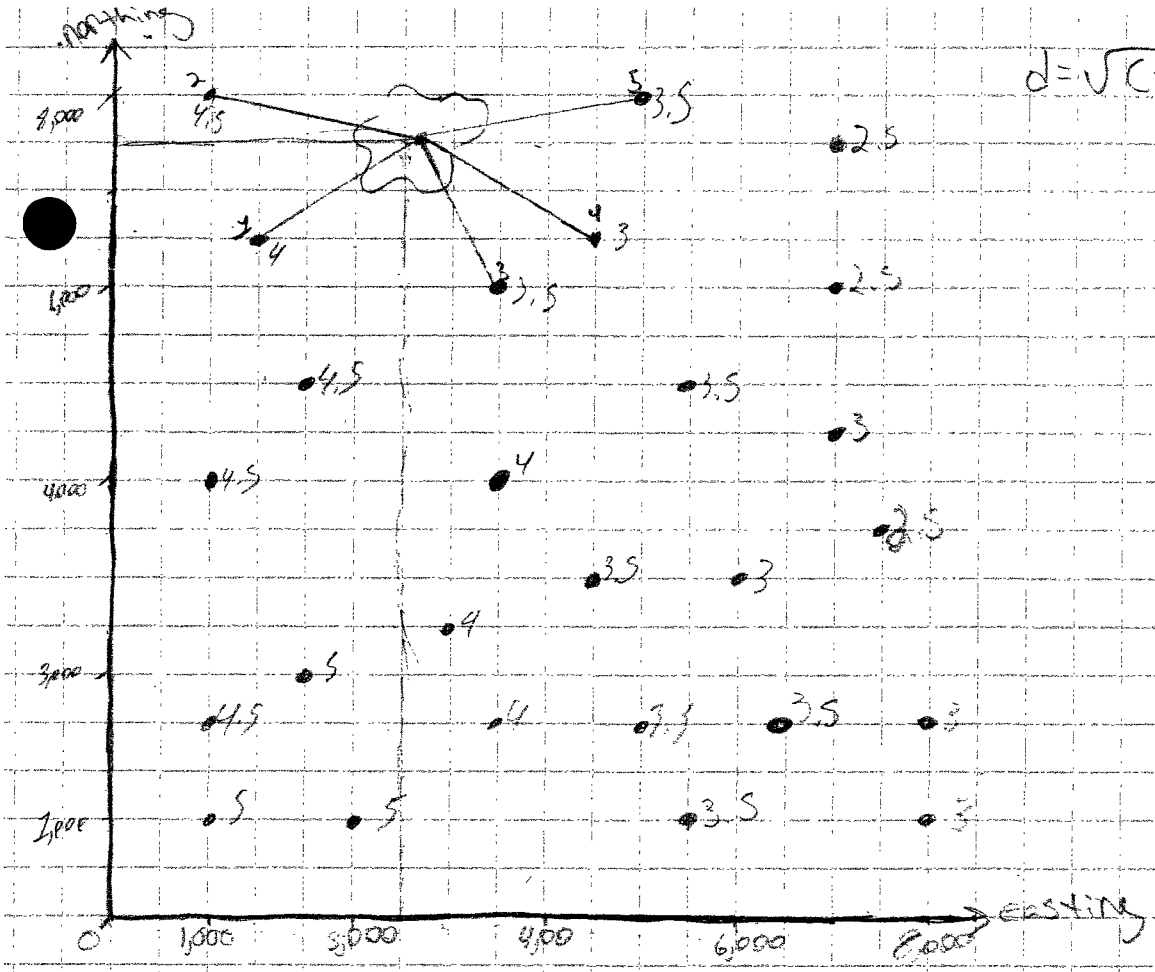
$$= 62.5 \int_0^{28} (5080)(28-y)\,dy$$

now → steps

$$= 124{,}460{,}000$$

# Inverse Distance to a Square

# Triangulation




$$d=\sqrt{(x_2-x_1)^2+(y^2-y^1)}$$

1 (6,500, 1,500), 2 (8,000, 1,000), 3 (6,000, 3,450), 4 (6,600, 4,150)
5 (8,000, 5,000) ÷ (7,500, 3,250)

~~1~~ (6,500 1,500) (7500 3,250)
$d=\sqrt{(7,500-6,500)^2+(3,250-1,500)^2}$
$d=(7000000)+(3062500)$
$d=\sqrt{4062500}$
$d=2016$ ft

2 (8,000, 1,000) (7,500, 3,250)
$d=\sqrt{(7,500-8,000)^2+(3,250-1,000)^2}$
$d=(250000)+(5062500)$
$d=\sqrt{5312500}$
$d=2305$ ft

3 (6,000, 3,450) (7,500, 3,250)
$d=(7,500-6,000)+(3,250-3,450)$
$d=(2250000)+(250000)$
$d=\sqrt{2500000}$
$d=1581$ ft

4

(6,500, 4,250) (7,500, 3,250)

$d = \sqrt{(7,500 - 6500) + (3,250 - 4,250)}$

$d = (1000000) + (1000000)$

$d = \sqrt{2000000}$

$d = 1414$ ft

5

(8,000, 5,000) (7,500, 3,250)

$d = \sqrt{(7,500 - 8,000) + (3,250 - 5,000)}$

$d = (250000) + (3062500)$

$d = \sqrt{3312500}$

$d = 1820$ ft

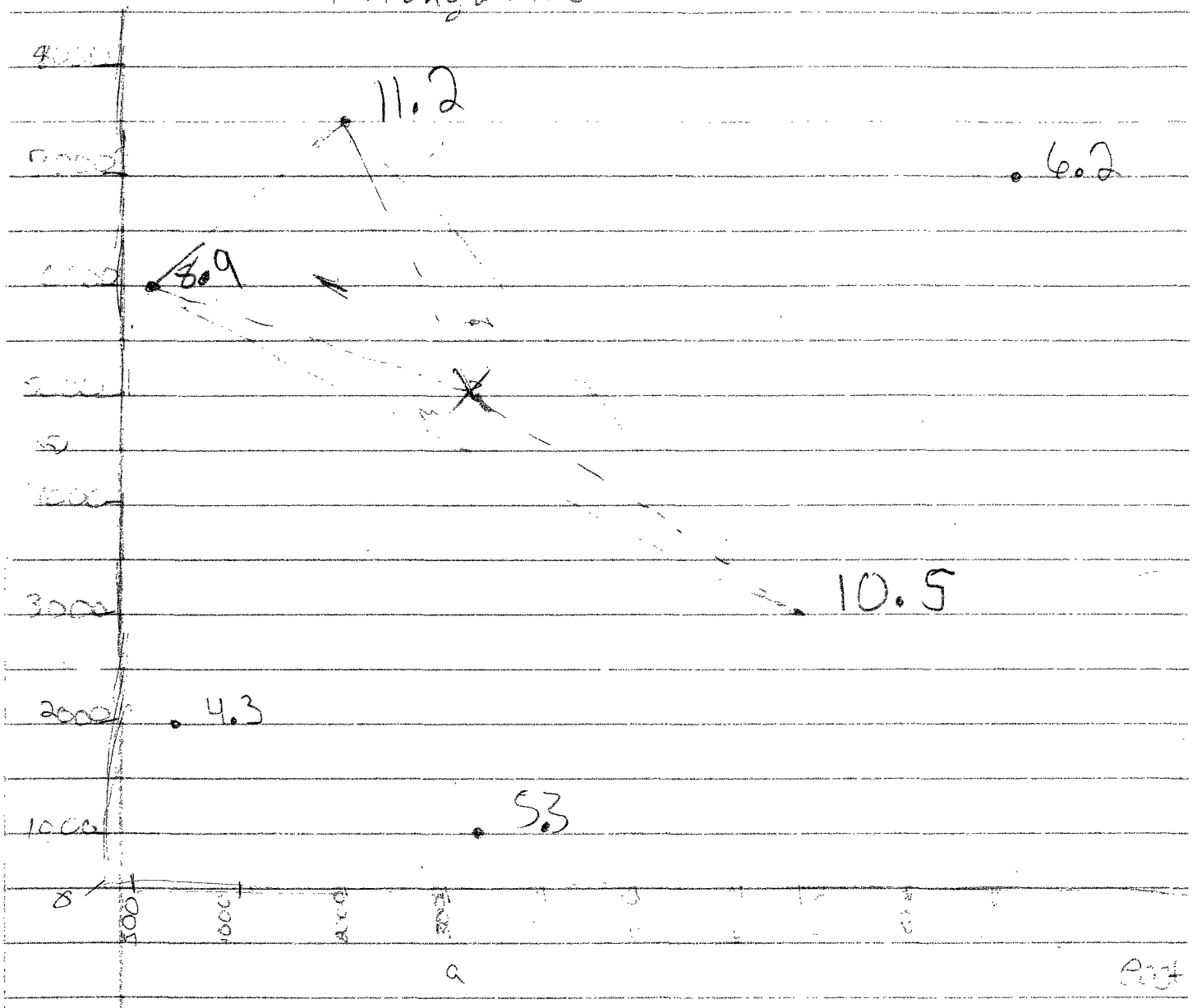
| Sample | Distance | $1/d_i^2$ | $w_i$ | $q_i$ | $w_i q_i$ |
|---|---|---|---|---|---|
| 1 | 2016 | 0.000000 24604 | .7503 | 4 | .6012 |
| 2 | 2305 | 0.000000 18816 | .1150 | 4.5 | .5175 |
| 3 | 1581 | 0.000000 40094 | .2495 | 3.5 | .8557 |
| 4 | 1414 | 0.000000 50015 | .3056 | 3 | .9168 |
| 5 | 1820 | 0.000000 30189 | .1844 | 3.5 | .6454 |
| Sums | | 0.000000 76364 | .9998 | | 3.5366 |

The Height of coal is about 3.5 ft.

(68, 140, 626)

North

# Triangulation




height

$(x, y, z)$ $\quad x + y + z = c$

$$500a + 6000b + c = 8.9$$
$$2000a + 7500b + c = 11.2$$
$$6500a + 3000b + c = 10.5$$

$$\begin{cases} 500a + 6000b + c = 8.9 \\ 2000a + 7500b + c = 11.2 \\ 6500a + 3000b + c = 10.5 \end{cases}$$

$500a + 6000b + c = 8.9$

$-1(2000a + 7500b + c = 11.2)$

$500a + 6000b + c = 8.9$

$+ -2000a + -7500b + -c = -11.2$

$-1500a - 1500b \quad -2.3$

$2000a + 7500b + c = 11.2$

$-1(6500a + 3000b + c = 10.5)$

$2000a + 7500b + c = 11.2$

$+ -6500a + -3000b - c = -10.5$

$-4500a + 4500b \quad .7$

$3(-1500a - 1500b = -2.3)$

$-4500a + 4500b = .7$

$-4500a - 4500b = -6.9$

$+ -4500a + 4500b = .7$

$-9000a \quad = 6.2$

$-9000$

$-9000$

$a = .0006$

Substitute

$-4500(.0006) + 4500b = .7$

$-2.7 + 4500b = .7$

$\frac{4500b}{4500} = \frac{3.4}{4500}$ $\quad b = .0007$

$500(.0006) + 6000(.0007) + c = 8.9$

$.3 + 4.2 + c = 8.9$

$(4.5) + c = 8.9$

$c = 4.4$

$.0006x + .0007y + 4.4 = z$

$.0006(3000) + .0007(5000) + 4.4 = z$

$1.8 + 3.5 + 4.4 = z$

$z = 9.7$

# Ventilation

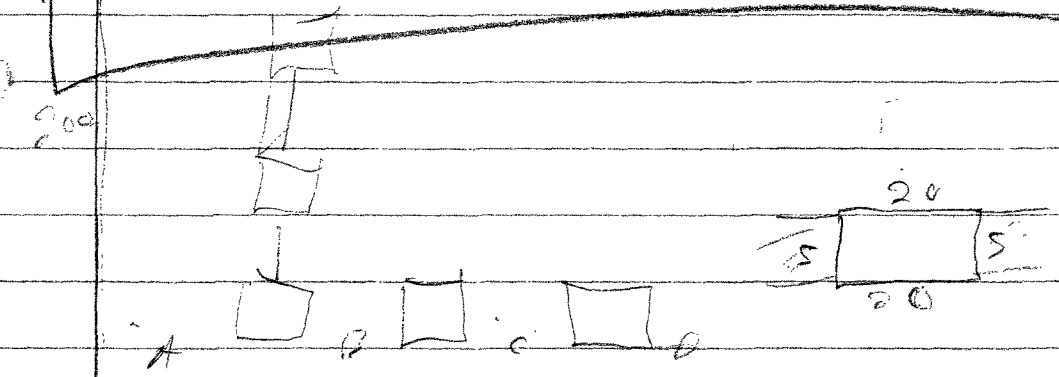
# Calculations

# Cool fair project

Kayla Torres

one inch of water corresponds to
pressure of 5.2 lbf (pounds per square foot)

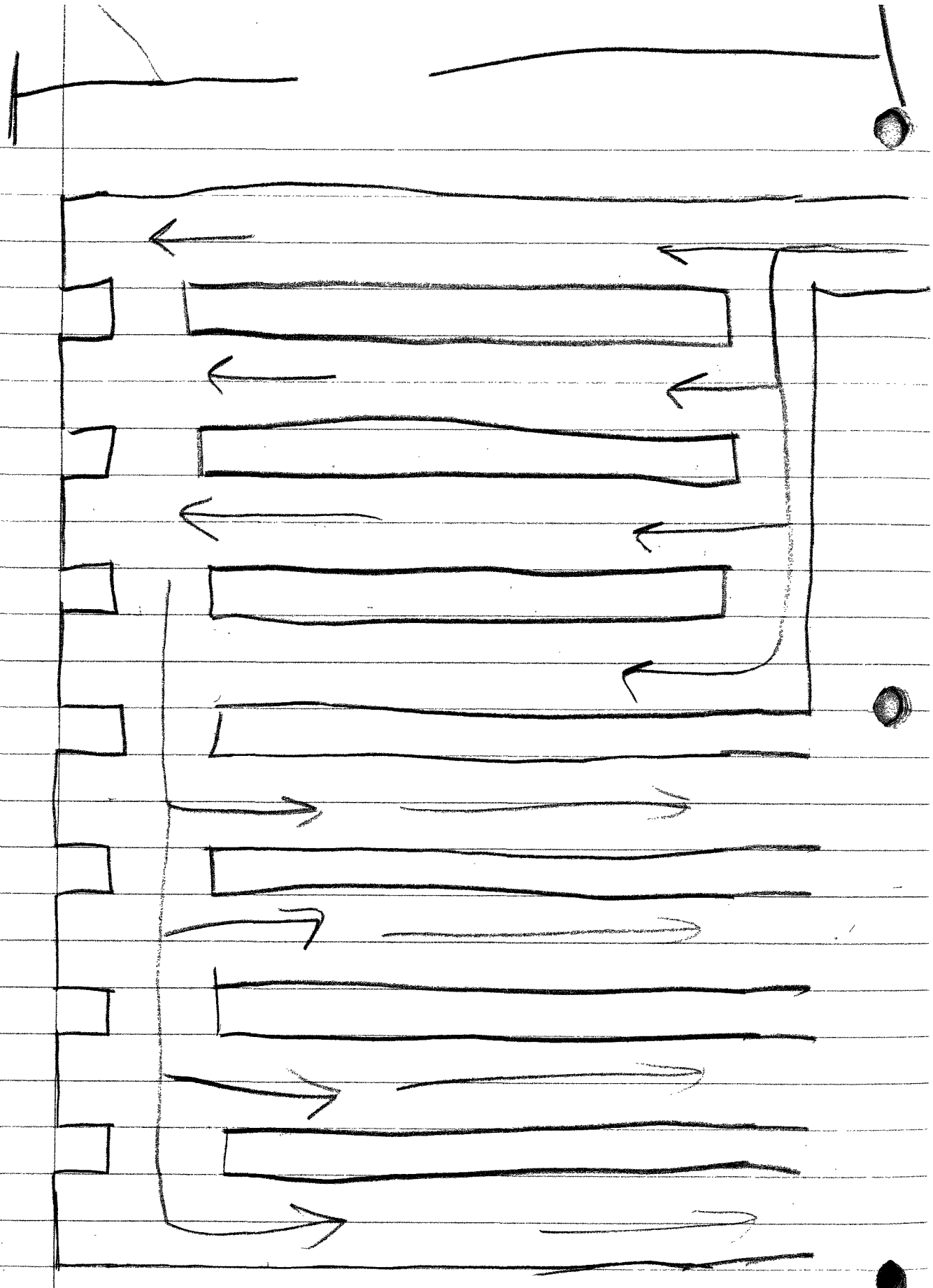
| Split | cross section in feet | Length in feet |
|---|---|---|
| A | 5 x 18 | 1590 |
| B | 7 x 20 | 1880 |
| C | 4 x 19 | 1720 |
| D | 6 x 21 | 1930 |




K = coefficient of friction
L = length of entry
D = perimeter of entry
A = cross sectional area

pounds per square foot

$$31{,}622.7 = 100\sqrt{(100/(100 \times 10^{-10})(2000)(50))}$$



$\frac{KSQ^2}{5.2A^3} = \frac{kQQ^2}{5.A^3}$

Calculator

intake - $62 \times 10^{-10}$
return - $82 \times 10^{-10}$

$(60 \times 10^{-1}(-10)(46)(2500)(40000^2))/(5.2(90)^{13})$

int

$\frac{62 \times 10^{-10}(46)(1590)(3(.57)^2}{5.2(90)^3} = .119$

(F)

return

$\frac{82 \times 10^{-}(46)(1590)(3(.57)^2)}{5.2(90)^3} = .158$

(B)

intake

$7 \times 20 = 140$

$7+7+20+20 = 54$

1880

51990

int. $\frac{62 \times 10^{-10}(54)(1880)(51990)^2}{5.2(140)^3} = .411$

out $\frac{82 \times 10^{-10}(54)(1880)(51990)^2}{5.2(140)^3} = .144$

(C)

$4 \times 19 = 76$ into

$4+4+19+19 = 46$

1720

2355

$\frac{62 \times 10^{-10}(46)(1720)(2355)^2}{5.2(76)^3} = .119$

out $82 \times 10^{-10}(46)(17$

A $90\left[\frac{90}{(100\times10^{-10})(1590)(46)}\right]$

31570.85083 = 31571

B $140\left[\frac{140}{(100\times10^{-10})(1880)(54)}\right]$ = 51990

51989.57282

C. $76\left[\frac{76}{(100\times10^{-10})(1720)(46)}\right]$ = 23555

23554.6822

D $126\left[\frac{126}{(100\times10^{-10})(1930)(59)}\right]$ = 43811

43810.70917

150,927

$\frac{31571}{150927}\times 190{,}000 = 39{,}744$

$\frac{51990}{150927}\times 190{,}000 = 65{,}430$

$\frac{23555}{150927}\times 190{,}000 = 29653$

$\frac{43811}{150927}\times 190{,}000 = 55{,}153$

intake - $.62 \times 10^{-10}$
return - $.82 \times 10^{-10}$

$\frac{1CIOQ}{5.2(A)^3}$

$A = L \times W$

1st L(x)9 → 0+4+4+19+19 = 46
2nd 6x21 L = 1720 1st
2nd = 1930 2nd 43811

$\frac{.62 \times 10^{-10}(46)(1720)(23555)}{5.2\,176^3} = .119$

$\frac{.82 \times 10^{-10}(54)(1930)(43811)}{5.2\,(126)^3} = .158$

intake
$\frac{.62 \times 10^{-10}(46)(1720)(23555)^2}{5.2(76)^3 .119}$

out.
$\frac{.82 \times 10^{-10}(46)(1720)(23555)^2}{5.2(76)^3 .158}$

intake
$\frac{.62 \times 10^{-10}(54)(1930)(43811)}{5.2(126)^3 .119}$

out $\frac{.82 \times 10^{-10}(54)(1930)(43811)}{5.2(126)^3 .158}$

A .277

$$\frac{5.2(.277)(31571)}{33,000} = 1.38$$

B $$\frac{5.2(.555)(51990)}{33,00} = 4.55$$

C $$\frac{5.2(.277)(23555)}{33,00} = 1.03$$

C $$\frac{5.2(.277)(43811)}{33,000} = 1.91$$

# Minimum Roof

# Bolt Size

Our problem:

7 rows, $n_1 = 7$

5 bolts per row, $n_2 = 5$

$$P = \frac{WtBL}{(n_1+1)(n_2+1)} \qquad P = \frac{(165)(4)(18)}{(7+1)(5+1)}$$

$$P = \frac{213840}{(8)(6)}$$

$$P = \frac{213840}{48}$$

$P = 4455$ (lb per bolt)

$\frac{4455 \cdot 16\,(2)}{40{,}000\ psi}$ ← to get Area

$A = .111375$ sq in

$\frac{.111375}{\pi} = .036$

$\sqrt{\frac{.036}{\pi}} = .107$

3/4

$\sqrt{.107} = .32$

$r = .32$

$r = 64$

# Figuring roof bolts

40- grade steel

## Determining "P"

$P = \frac{wt\ B\ L}{(n_1+1)(n_2+1)}$

1. $P = \frac{(160)(4)(25)(33)}{(11)(5)}$
2. $P = \frac{(640)(25)(33)}{(11)(5)}$
3. $P = \frac{(16000)(33)}{(11)(5)}$
4. $P = \frac{(528000)}{(55)}$
5. $P = 9600$

## Determining "A"

$A = \frac{P}{40{,}000}$

1. $\frac{9600(2)}{40{,}000} = a$
2. $\frac{19{,}200}{40{,}000} = a$
3. $.48 = a$

## Determining the radius

1. $\frac{.48}{\pi} = \frac{\pi r^2}{\pi}$
2. $\sqrt{\frac{.48}{\pi}} = \frac{\pi r^2}{\pi}$ ($\pi$ cancel's out)
3. $\sqrt{\frac{.48}{\pi}} = r^2$
4. $.48 \div \pi$
5. $r = .220\,(6)\,3155\,82$ (round up)

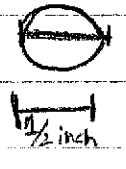
So it's now

$r = .221$

## Finishing up

1. $2r = 2(.221)$
2. $2r = .442$

So, about a 1/2 inch bolt



# Coal Song Lyrics

"Shuttlecart"

Shuttlecart

I live in Kentucky,
The land of the mines
I've been mining there
since '59

I've been growing old
Working all day,
All night
Made it through a day
In 14 hours

Workin' with machines
with massive powers
Hopin to God, that I
Don't work tonight

So rock me mama like
A shuttlecart
Rock me mama,
Before we part
Hey
Mama rock me

Workin' all day
Through The wind and the rain
To get that coal on a southbound train
Hey
Mama rock me

Could've worked the factories
in the northern states
But mining coal in Kentucky
That was my fate

My daddy was a miner
Now I've takin his place
Working the harsh
southern winters now

Don't ask me how we do it,
I don't know how
My face is turning black
From living this old life so long

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Rock me mama,
Before we part
Hey
Mama rock me

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